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THESIS

AN ALTERNATIVE TESTING METHODOLOGY FOR TOW MISSILE TRAINING SYSTEMS

by

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September, 1996

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This thesis explores alternatives to the current testing methodology being applied to two TOW missile training systems. This thesis contends that current practices do not adequately prove system accuracy or system training value. Research emphasis is placed upon identifying those factors involved in assessing system accuracy currently being overlooked. The objective is that future government testing will address system accuracy and training value in detail. Following a description of current techniques, an alternative to current accuracy assessment is presented using the precepts of direct fire gunnery based upon a series of statistical treatments that quantify system accuracy and contract specification compliance. Data collection enhancements, potential test design modifications, and a methodical data analysis plan is presented An alternative testing scenario is developed, based upon the recommended changes in test methodology. Finally, observations and recommendations are provided pertaining to program management of the two TOW missile training systems in an effort to optimize program structure. The underlying premise is that the application of operations research skills to validate system performance will improve the final product fielded to U.S. Marines and Soldiers.

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AN ALTERNATIVE TESTING METHODOLOGY FOR TOW MISSILE TRAINING SYSTEMS

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Submitted in partial fulfillment
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ABSTRACT

This thesis explores alternatives to current testing methodology being applied to two TOW missile training systems. This thesis contends that current practices do not adequately prove system accuracy or system training value. Research emphasis is placed upon identifying those factors involved in assessing system accuracy currently being overlooked. The objective is that future government testing will address system accuracy and training value in detail. Following a description of current techniques, an alternative to current accuracy assessment is presented using the precepts of direct fire gunnery based upon a series of statistical treatments that quantify system accuracy and contract specification compliance. Data collection enhancements, potential test design modifications, and a methodical data analysis plan is presented. An alternative testing scenario is developed based upon the recommended changes in test methodology. Finally, observations and recommendations are provided pertaining to program management of the two TOW missile training systems in an effort to optimize program structure. The underlying premise is that the application of operations research skills to validate system performance will improve the final product fielded to U.S. Marines and Soldiers.

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And finally, to my wife Anne-Marie and to my daughter, Brittany, who understood why their husband and father was simply not available for the most important things at the most important times.

EXECUTIVE SUMMARY

The pursuit of realistic training has taken on greater importance as the price of munitions and the cost of using live-fire training ranges has risen dramatically. In 1986, the U.S. Army and U.S. Marine Corps contracted to develop a Precision Gunnery Training System (PGTS) that would permit inexpensive training of Tube Launched, Optically Tracked, Wire Guided (TOW) gunners. Following recent technological advances in thermal imagery and computer processing power, enhancements to the PGTS program have been pursued to match the advancements being made in the TOW tactical system. Two resulting PGTS programs, currently under development, are the focus of this thesis. The subject programs are the Enhanced Instructors Station, commonly referred to as REHOST, and the Tactical Engagement System (TES).

This thesis, based upon a seven–week internship with the prime PGTS contractor, questions the validity of the training value of the REHOST program and the adequacy of the current approach to assessing the TES system's accuracy. Neither issue is adequately addressed in program documentation which leads to the conclusion that sound procurement decisions cannot be made at this point in the procurement cycle. The intent of this thesis is to provide alternatives to current testing methodology that might enhance future testing evolutions.

Following a description of the currently-fielded TOW system and PGTS training functions, the Improved Tactical Acquisition System (ITAS) is introduced as the new host system of the PGTS family. It is the development of ITAS technology that is driving TES procurement. The enhanced thermal and autotrack capabilities of the ITAS require a

modification of the PGTS family in order to maintain realism in training.

The current approach to program testing is highlighted as lacking in data collection and contract specification compliance. Three weeks of observed testing at Redstone Arsenal serves as the basis of the testing research presented herein. Recommendations are made to enhance the current testing process in an effort to establish quantitative measures of TES accuracy. A similar set of recommendations is made regarding REHOST specification compliance.

Having provided an alternative to current testing practices, the thesis recommends an analytical approach to assessing TES system accuracy. A scenario is developed that utilizes the proposed alternative to current testing practices. Emphasis is placed upon redesigning the data collection plan associated with this effort and identifying potential categories of variability affecting system accuracy. Several statistical treatments are then proposed in an effort to establish quantitative measures of effectiveness to be used in assessing TES accuracy. Probability-of-hit upon a circular target, multiple regression, hypothesis testing, a binomial distribution assessment, and nonparametric alternatives are provided as potential alternatives to the "hit or miss" approach currently in use. An example scenario, using simulated data, is then conducted implementing the use of hypothesis testing and confidence intervals in assessing system accuracy.

Finally, the REHOST system's suitability as a meaningful training system is assessed. Lack of concurrent development of tactical and training systems and the fact that the REHOST system is not based upon a fielded tactical system are emphasized as major contributors to a current lack of realism in the REHOST system. Future research is

recommended to explore the correlation between gunner performance using the REHOST system and similar performance using fielded tactical systems.

Fielding quality training or tactical systems requires innovation in today's austere budget environment. Specific measures of effectiveness must be required throughout the procurement process. No knowledgeable decision may be made without some quantifiable measure of performance. Therefore, it would not be prudent to make a procurement decision on the PGTS systems based solely upon "hit or miss" testing in the case of the TES system, or prior to some determination of training value in the case of the REHOST system.

I. INTRODUCTION

The March 1996 version of the DoD 5000 series of procurement guidelines "... requires an acquisition environment that makes DoD the smartest, most responsive buyer of the best goods and services, that meet our warfighters' needs at the best dollar value over the life of the product." [Ref. 1]

A. BACKGROUND

The pursuit of realistic training has taken on greater importance as the price of munitions and the costs involved in the use of live-fire training ranges have risen dramatically. Simultaneous to the rise in weapons costs, pressures on defense spending have increased as well. The U.S. Army and the U.S. Marine Corps in 1986 sought to address this problem as it applies to Tube Launched, Optically Tracked, Wire Guided (TOW) missile training with the development of the Precision Gunnery Training System (PGTS). The PGTS program was initiated to address tactical anti-armor training without the use of live-fire ranges or the expenditure of live ammunition. Through mid 1995, deliveries of approximately 450 Field Tactical Trainers (FTTs), approximately 350 Gunnery Trainers (GTs) and approximately 275 vehicle mounted systems had been fielded to soldiers and marines at cumulative contract prices exceeding 85 million dollars. [Ref. 2]

Two recent developments have brought forth an initiative to improve upon these currently fielded training systems. The first development is the advancement of technology in the areas of computer processing power and graphical user interfaces. The second development is a U.S. Army initiative to field a second generation Forward

Looking Infrared (FLIR) sight for the TOW tactical system through an Advanced Concepts Technology Demonstration (ACTD) program.

B. CHALLENGE

The effective, timely and concurrent development of tactical and training systems demands a new approach to addressing program issues. This thesis proposes that a marriage of operations research skills and recent acquisition reform initiatives constitute the basis for success. Acquisition of quality weapons systems requires constant consideration of the operational objectives intended to be met by a given procurement. The majority of development effort must be applied to developing measures of effectiveness that can be quantified so that program decision makers might make informed procurement decisions. The combined talents of management, Integrated Product Teams (IPTs), and analysts capable of quantifying weapon system performance and cost parameters must be applied in tandem to ensure the successful accomplishment of this requirement.

C. OBJECTIVES

This thesis is based upon the author's participation in a seven week internship at the prime contractor's PGTS program headquarters. It will suggest an alternative approach to assessing the accuracy of the Field Tactical Trainer, referred to in this thesis as the Tactical Engagement Simulation (TES) mode of the PGTS family. An alternative to current testing methodology being utilized in this program is presented and, as a

secondary thesis objective, programmatic issues surrounding the indoor Gunnery Trainer, commonly referred to as the REHOST improved instructor's station are addressed. It is hoped that the testing alternatives presented in this thesis might be useful in future government testing efforts. It must be noted that the PGTS contractor's enthusiasm for input from an operational user and the ability to access all program areas greatly facilitated the author's quest to meet these thesis objectives.

The thesis is organized into the following areas:

- An introduction to the currently fielded TOW tactical and PGTS training systems is provided.
- Enhancements that are currently being developed are introduced.
- Current techniques being utilized to assess the effectiveness of the developing systems are described.
- An alternative to current testing techniques is presented.
- A test scenario using the above alternative test methodology is provided.
- Finally, program observations and recommendations are made pertaining to the subject training systems.

The approach taken to address the above areas consists of a description of the current process followed by recommendations to improve that process. Emphasis is placed upon quantifying the accuracy parameters described in Chapters III through V in order to prove that the training systems meet the requirements set forth in Reference 2. Due to the author's repeated involvement in the procurement process, observations and recommendations are also made pertaining to the management and organizational practices of government and contractor program offices.

II. PROGRAM DESCRIPTION

A. CURRENT SYSTEMS

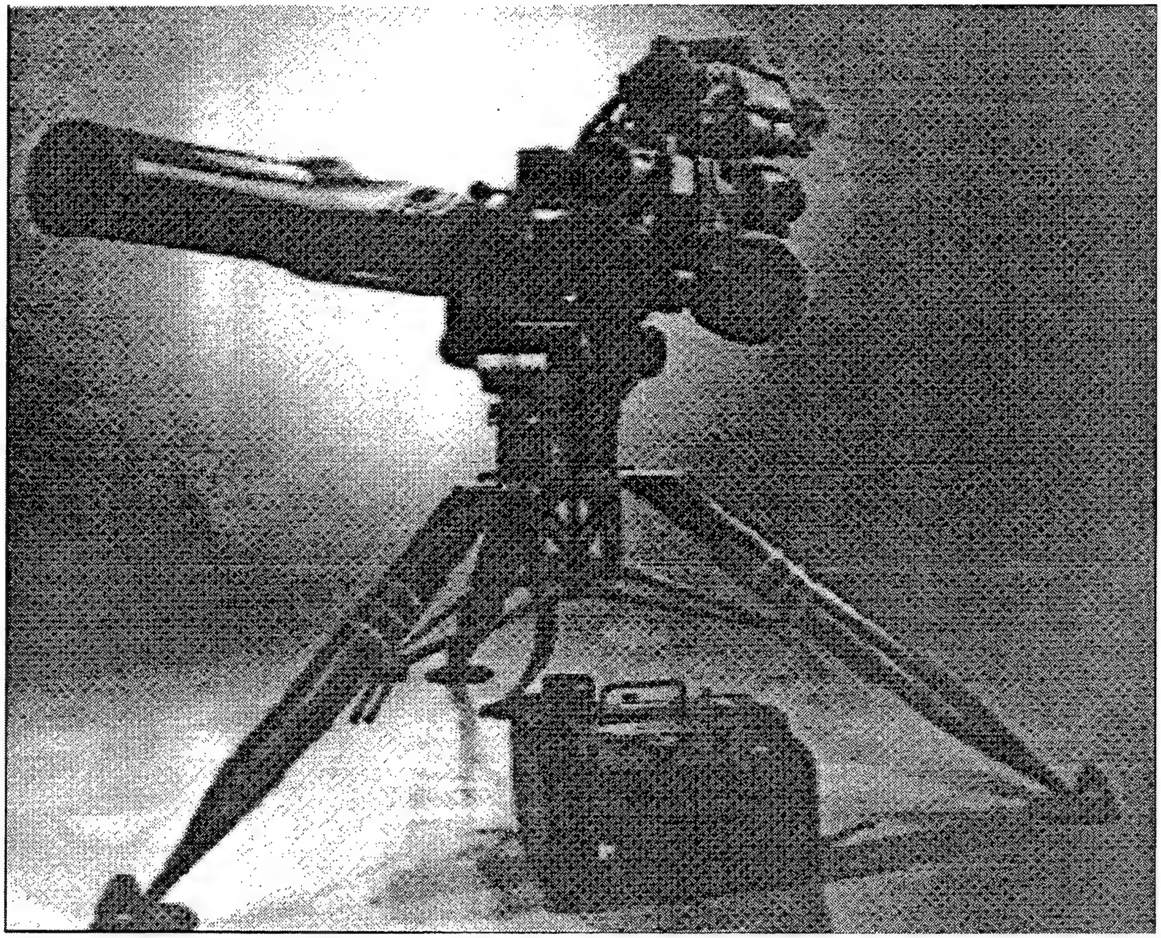

Figure 1: The current TOW system in its ground mount configuration. Both the day and night thermal viewer are visible atop the TOW system, while the Fire Control Subsystem (FCS) is placed below the tripod. The source of this photo is Reference 3.

To begin discussion involving the PGTS training systems being developed, one must possess an understanding of the tactical system that PGTS is designed to emulate. The TOW system is the primary anti-armor weapon of the infantry forces in the U.S. Army and the U.S. Marine Corps. The current tactical TOW missile system is deployed on a variety of platforms. It is shown in Figure 1 in its ground mount configuration. The

configuration. The system provides the gunner with two alternative optical devices to acquire and engage targets. One sight provides daylight engagement capability while the other provides passive technology that permits limited visibility engagements during acceptable ambient light conditions. The system must align a thermal or xenon beacon with a signal receptor in the daylight sight. The missile beacon and signal receptor are likewise aligned with the day reticle or aimpoint. The thermal viewer is then aligned to the day sight. This boresighting or alignment process establishes baseline system accuracy. Throughout any engagement, the TOW gunner must manually guide the wire-guided TOW missile to the intended target by using the hand grips of the TOW traversing unit. The traversing unit rests upon the tripod visible in Figure 1 and sends correction signals to the missile via the wire guide. In order to ensure that the target is within the maximum 3750 meter range capability of the TOW system, the crew must currently obtain range-to-target information from an outside source. Recent missile advances permit top-down attack in addition to more conventional side aspect engagements. The current PGTS family of training devices attempts to emulate the TOW missile flight characteristics within the ITAS optical system for use by field units conducting TOW gunnery training where live ordnance is not deemed efficient.

B. OUTDOOR TRAINING ENHANCEMENTS

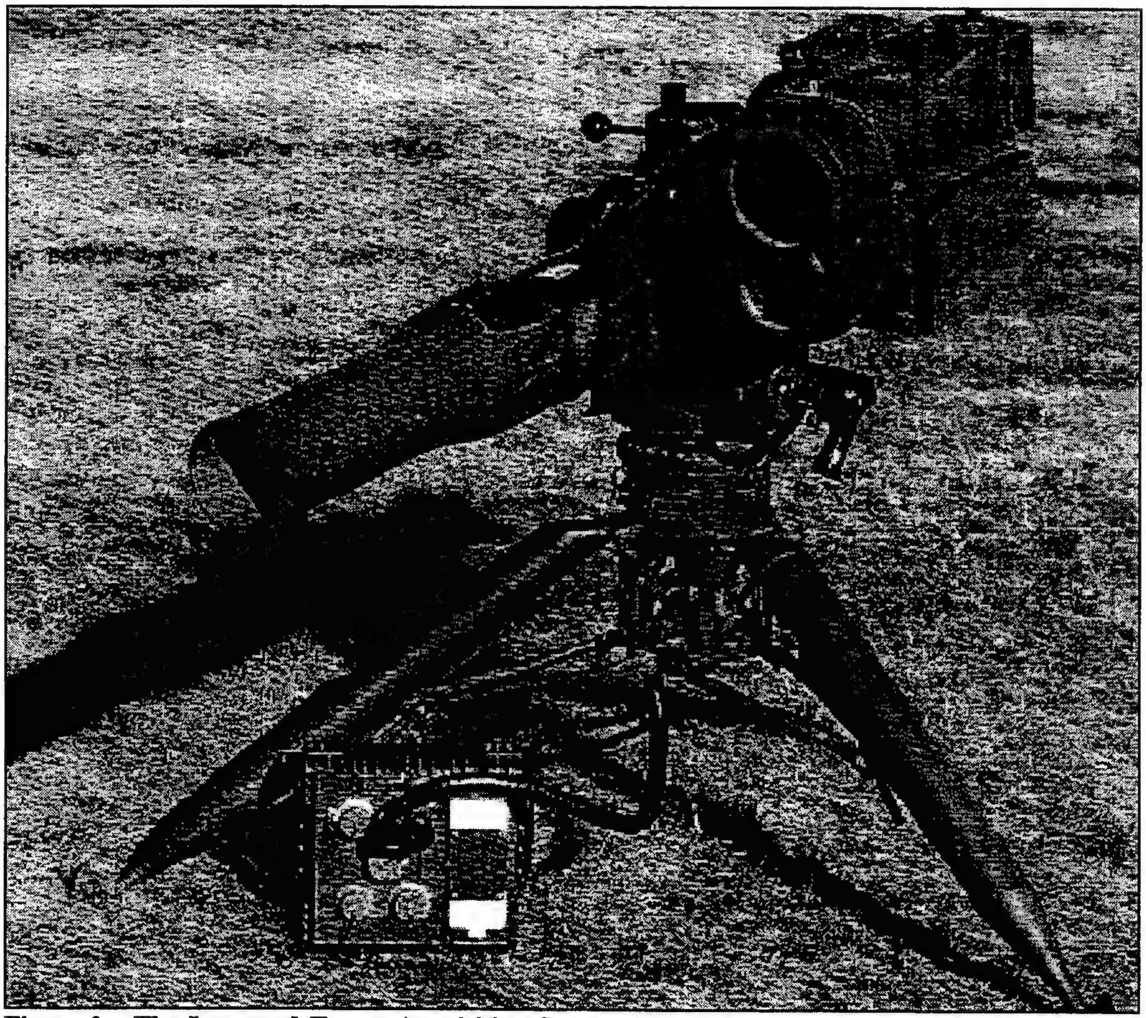

Figure 2: The Improved Target Acquisition System (ITAS) featuring the integrated Day / Night viewer. The FCS shown is similar to that in Figure 1. The source of this photo is Reference 4.

Due to the development of the ITAS, shown in Figure 2, an effort to develop compatible PGTS training systems has commenced. The goal is to provide equivalent or enhanced capabilities over the current PGTS family.

The major improvements to the PGTS outdoor training systems being undertaken by the training system developer are threefold: [Ref. 5]

1. An *Embedded Training (ET)* mode will permit the gunner to fly simulated TOW missiles against targets of opportunity in the training area being utilized. ET is a single circuit card that fits into the current fire control system (FCS), also shown in Figure 2. It permits the gunner to fly a simulated missile while looking through the integrated sight in thermal mode with or without autotrack engaged. The ET enhancement has progressed through initial government procurement. The ET system is not a subject of interest for this thesis but this system does represent a new training feature over current PGTS systems.

2. A *Tactical Engagement Simulation (TES)* mode builds upon the ET mode and permits a gunner to engage targets of opportunity on the training battlefield and receive performance feedback via the Multiple Integrated Laser Engagement System (MILES II) training system. MILES provides an opportunity for most weapons systems in the U.S. inventory to engage one another by emitting a coded laser burst that is received and returned by receptor belts attached to a target system. The laser code or intensity of the pulse received by the target determines whether the engagement result is a kill, miss, or some other less catastrophic degree of battle damage. The TES training system is also a new capability over existing training systems and will be the primary focus of this thesis.

3. The *Precision Gunnery (PG)* mode will enable the gunner to be evaluated in terms of target tracking proficiency. The PG mode will be the ITAS equivalent to current TOW gunnery evaluation capability.

All three of these enhancements will be developed for use with the TOW Improved Target Acquisition System (ITAS). This system represents the latest FLIR

technology that is replacing the current optical and thermal sights with an integrated sight capable of day and limited visibility engagements through the same ocular. FLIR development is proceeding under a separate contract by a different prime contractor. Enhancements of interest to the current TOW tactical gunnery system under the ITAS program include:

- Increased target detection ranges under all visibility conditions
- Autotracking of targets in thermal mode
- Organic rangefinding capability. [Ref. 6]

These enhancements are exceptional and will bring the TOW gunner effectively to the 21st century battlefield. Autotracking of potential targets, organic rangefinding and improved limited visibility optics will greatly enhance this weapon's effectiveness in the hands of a capable crew. Similarly, the enhancements being made to the PGTS training systems do not impact upon the performance of the tactical system while engaged in live fire. The PGTS is therefore designed to remain passive in the TOW ITAS fire control system until called into use by the crew. The ultimate goal is to possess an integrated tactical and training capability.

C. INDOOR TRAINING ENHANCEMENTS

The enhancements described to this point all pertain to the TOW gunnery system used in the field environment. A final enhancement to the PGTS family and the secondary subject of this thesis is the improved instructor's station, or gunnery trainer, used during indoor training and shown in Figure 3. This program is known as the REHOST program and is designed to upgrade the current video-based training system.

This training system permits TOW gunners to engage video targets displayed in a mock TOW sighting system. Audio and visual effects are provided throughout the engagement scenario. The upgrade being performed by the contractor consists of a computer upgrade to the Pentium® processor level and the capability that permits instructor programming of threat scenarios for the student. [Ref. 7]

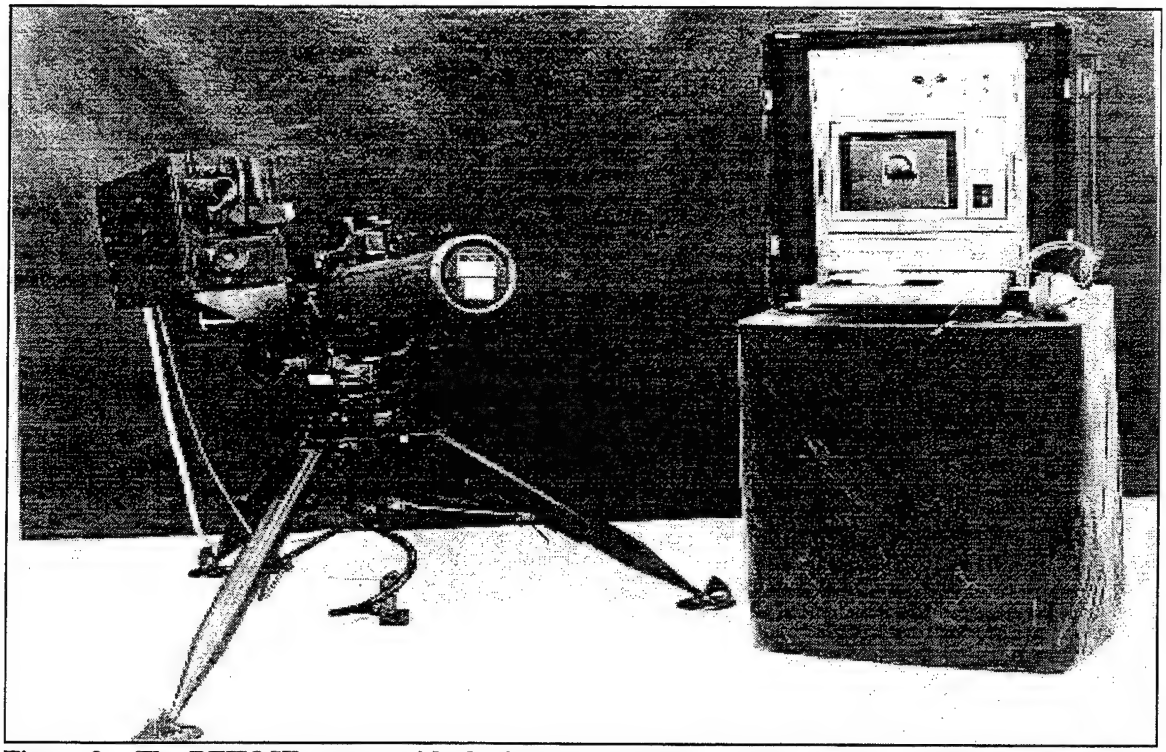

Figure 3: The REHOST system with the instructor station (right) and the student station (left). Notice the difference in configuration between the student station, shown here, and the TOW system in Figure 1. The source of this photo is Reference 7.

The PGTS program is being executed under the original 1986 contract as individual contract modifications for each of the major subsystems: Tactical Engagement Simulation (TES), Embedded Training (ET), Precision Gunnery (PG), and REHOST. ET, TES and REHOST are preparing for government testing phases and potential production contract award while the PG program remains in development.

III. CURRENT TESTING METHODOLOGY

"Test and evaluation programs shall be structured to provide essential information to decision makers, assess attainment of technical performance parameters, and determine whether systems are operationally effective, suitable, and survivable for intended use." [Ref. 8]

A. THE TEST PLAN

The Redstone Arsenal in Hunstville, Alabama was the scene of primary testing for validation of TES system performance and the contractor's Trainer Test Procedures. The Redstone government test range had been obtained by the contractor through an agreement with the government program developer. The results of this test phase would provide an indication of system maturity as the contractor was preparing to sell six or seven prototype TES systems to the government. The procedures used to guide the testing process were exceptionally detailed for this stage of the development process due primarily to the fact that they had been modeled from the earlier development effort of the ET system that had been previously assessed through the government's acceptance process. The pertinent sections of these trainer test procedures are included in the Appendix. The approach to assessing the current testing process began with a study of the contract under which the contractor was performing. Due to the fact that this 1993 contract was a relatively simple modification to the original 1986 document, the study of the 1993 version of contract specifications to be tested in Redstone was completed expeditiously. Subsequent to the contract specification review, a review of the draft test procedures was conducted in an effort to determine whether a complete matrix consisting

of contract requirements versus test procedures existed. One should anticipate a direct correlation between contract requirements and test procedures. This correlation exists in the TES program, however, the lack of detailed specifications regarding system accuracy is a cause for concern. [Ref. 9]

B. INITIAL TEST EXECUTION

The testing at Redstone Arsenal commenced with a detailed series of diagnostic tests upon the TES system conducted by a systems engineer, one or two software engineers, a quality assurance representative and the author. The use of a diagnostic terminal that passively observed system functions provided the window through which performance was to be evaluated. Information passed to this diagnostic terminal by the ITAS system included trigger pull, missile launch, tracking rate information and MILES engagement code information. Throughout the testing process, as system malfunctions occurred, Electronically Programmable Read Only Memory (EPROM) chips could be recoded, thereby permitting updated software inputs that control TES simulated missile flight. The software troubleshooting process required daily, round-trip Federal Express shipment of EPROMs between Huntsville, Alabama and Long Island, New York with each modification, since the capability to "burn" new code onto the EPROMs was not resident at Huntsville. This long distance process was time-consuming and not conducive to effective range utilization. The software modification process also revealed numerous software shortcomings in the system that indicated further lab work would be beneficial prior to field testing. The software problems encountered were not unusual for this stage

of system development, however, the frequency of the software problems point to a lack of system readiness for the field.

This initial phase of testing also revealed shortfalls in the communication network between the two prime contractors involved, and the government. Due to the proprietary nature of information regarding the ITAS tactical system and the TES training subsystem, cross-communication of system design features was extremely limited. Although a technical representative from the ITAS contractor was available for troubleshooting the host system, all fire control data used in the TES training subsystem came through a data bus, which is standard on most military systems. However, the true meaning of information being passed to the data bus was not always clear. The data bus serves as a common access point to system performance information that has previously been designated as necessary information for system integration. This method of information exchange provides that data which is necessary for contractors to perform specified tasks while retaining the proprietary design rights of the original prime contractor. The importance of a detailed Interface Control Document (ICD) between contractors using the common data bus became evident. A program management Integrated Product Team (IPT) could serve this purpose well and lead to a joint development effort of tactical (ITAS) and training (PGTS) systems.

C. CURRENT ACCURACY ASSESSMENT TECHNIQUE

The method utilized in assessing system accuracy at Redstone Arsenal consisted of engaging a High Mobility, Multi-Purposed, Wheeled Vehicle (HMMWV) fitted with

the Multiple Integrated Laser Engagement System (MILES) system. The ranges varied from zero to 4000 meters in thermal and day sight mode. Once a target was engaged, the MILES returns were interpreted and another engagement began. Limited records of these engagements were maintained. The author attempted to capture the majority of available data regarding results of the engagements. The results of this data collection effort are provided in Table 1. At ranges of 500 to 3750 meters, scoring event probabilities calculated from this data ranged from .67 to .80, significantly below the contract required .95 probability of scoring event occurrence. [Ref. 6] A *scoring event* is defined as any indication that the MILES laser has impacted any portion of the engaged target. The scoring event reference is specific to the MILES system of target engagement using the Blast Laser Transmitter (BLT). A MILES engagement occurs when the BLT sends a wide beam pulse at a target fitted with laser receptors. The intention is to return a signal to the gunner when a target is successfully engaged. A scoring event does not necessarily translate to a MILES "kill." A kill result is dependent on the strength of the laser pulse received by the target receptors, and therefore, places a premium upon system accuracy.

RANGE	DAY		NIGHT				COMMENTS
	shots fired	hits	shots fired	hits	P(hit) day	P(hit) night	
200	2	2	2	2	1.0	1.0	min arming range
500	2	2	3	2	1.0	.67	
1000	4	3	4	3	.75	.75	
1500	4	3	4	3	.75	.75	
2500	4	4	4	3	1.0	.75	
3000	5	4	5	4	.8	.8	
3500	6	5	6	4	.82	.67	
3750	8	6	8	6	.75	.75	max engage range
4000	2	0	2	0	0	0	desired result

Table 1: TES engagement data collected at Redstone Arsenal

D. INITIAL SPECIFICATION AND DATA CONCERNS

Following the observation of current testing and a review of the contract specifications, concerns regarding the definition of realistic performance parameters and adequate data collection to verify those parameters must be addressed. For example, the reliability performance parameter of the system is only encumbered by the requirement that any embedded subsystem shall not degrade the ITAS tactical system's reliability. [Ref. 5] This implies that the TES mode must have a reliability of 100%. The event of 100% reliability of any system is highly unlikely. Even though TES spends the majority of time in a passive mode, when in use, it does interact with the ITAS system via the Fire Control Subsystem, and thus presents a failure possibility. Specifications and accuracy requirements that necessitate a .95 probability that a scoring event occurs, lead to two system design problems. First, without the knowledge of system aimpoint, no means exist to gather miss distance data. Secondly, in the thermal mode, the tendency of any gunner will be to engage "center of visible mass." In the thermal mode, this will normally be the center of the "hot spot" of the target to be engaged. In autotrack mode, the ITAS is determining this spot through a sampling of target temperatures. [Ref. 6] Although effective for engaging targets with live ordnance, this situation will have the gunner engaging a point on the target that may not necessarily be the MILES center of visible mass. The result is a potential bias in the results of thermal engagements using the TES system with the ITAS in autotrack mode. Although the ITAS boresight and autotrack procedures leading to system aimpoint are proprietary, the data regarding the final location of the ITAS reticle (system aimpoint) and any updates performed by the

ITAS system is critical to assessing proper TES training system functioning. The lack of available data severely limits the analytical approaches available in assessing system performance. Table 1 provides an example of the cumulative data for a week of testing at Redstone Arsenal. It is indicative of the lack of an adequate data collection plan supportive of analysis in determining system performance.

The lack of a data collection effort made it apparent that any parametric analysis of system accuracy would be conducted only through simulation. For this reason, the author's research efforts are focused upon developing an alternative to the current test methodology being utilized.

IV. AN ALTERNATIVE TEST METHODOLOGY

A. INTRODUCTION

Prior to the start of any testing, it is imperative that the goals of testing be established well before the first day on the test range or in the laboratory. The ability to define factors affecting system performance must drive test design. For example, an appropriate test of system accuracy must begin with defining those variables, or biases, that impact upon system accuracy. It is through this type of testing process, whether government or contractor sponsored, that system maturity is attained. A test-fix-test approach encourages a systematic troubleshooting process leading to the development of a system that meets a stated mission need. The intent of this chapter is to provide an alternative testing methodology focused primarily upon assessing accuracy of the TES system, but with applications to REHOST as well. Again, the hope is that this proposal will benefit future testing efforts. It is not feasible to address all aspects of system testing in their entirety here. The emphasis will be placed upon assessing system accuracy, but this approach does have applications to ancillary test areas such as environmental, shock, and reliability testing.

B. A PROPOSED TEST METHODOLOGY

Initial emphasis in approaching testing is best directed toward establishing a core group of trained test personnel. This core group, operating as a distinct testing–oriented IPT, could be resident in the contractor's quality assurance section. As programs progress

and program personnel gain experience in testing, expertise will eventually be resident throughout the organization. This approach is suitable to programs of any degree of complexity. It is sufficiently generic so that a program manager can easily tailor his test team to meet his system's test requirements. Aside from the literature available on the testing process, training in test execution can be obtained through the following means:

◆ Defense Systems Management College (DSMC) provides short courses such as the two–week Test and Evaluation Management Course (TEMC) and the full Program Managers course. Contractor participation is normally welcome, as it fosters the government/industry team concept.

◆ Government test agencies can also provide a wealth of testing knowledge. The corporate knowledge resident at such agencies as the Test and Evaluation Command (TECOM), the Army Materiel Systems Analysis Agency (AMSAA), and a host of similar organizations can be of assistance in executing any test evolution.

◆ Government program offices will readily share their testing experiences in pursuit of fielding superior systems. Assistance lent by the government early in program development will facilitate the government testing phase prior to production contract award.

◆ Historical documentation of previous programs can also provide useful guides to testing. The use of previous Test and Evaluation Master Plans (TEMPs) and Data Collection and Analysis plans will serve to provide insights into test design concepts as well as maintain homogeneity among test documents where necessary and convenient.

Prior to the execution of testing, a thorough systems analysis should be conducted. It is possible, depending upon system design, that simultaneous testing of subsystems might be conducted. This parallel approach to testing can save scarce resources. However, the same systems analysis may point out that future known design changes make immediate testing of a particular subsystem fruitless at the current time. Repetition of test events due to system design changes, particularly in software, are expensive and time consuming.

This systems analysis will establish a critical path in the system design process. The critical path identifies those events that are dependent upon one another for completion or modification. In other words, critical path events must be accomplished sequentially. Once identified, the critical path can be used to develop the sequence of testing. Critical path testing events are scheduled so that a future modification in design does not require repetition of previous tests. Meanwhile, subsystem tests not on the critical path should be available for execution during system modification periods or unique test facility availability circumstances. The ability for program managers to have "hip-pocket" testing events ready to go at any time is an indicator of program efficiency and flexibility.

Having conducted the systems analysis and defined the critical path of testing, it is time to begin identification of technical aspects of the testing process. This process begins with the contractually binding design specifications and continues through identification of data items in support of meeting requirements. A prime example is the pursuit of achieving a contractual degree of accuracy. The approach to meeting accuracy

goals can be achieved in a myriad of ways. Identifying the factors affecting accuracy and a test design that measures the factors of interest, must go hand in hand. The goal of the test design team must be to identify the variables, both dependent and independent, and a plan to fix, control, and measure those variables where possible. Although the tester cannot hope to control independent variables such as weather, he must recognize those that impact system performance. The process of identifying data requirements is best started by identifying the essential elements of analysis (EEAs). The EEAs serve to provide a guide to required data collection efforts and test design. Each EEA will likely indicate a single data item requirement that must be drawn during testing. Each of the EEA's and their associated data items may then form an overall measure of effectiveness. In the case of assessing system accuracy, each EEA will identify an individual data element related to an identified bias that affects system accuracy. These individual data elements will cumulatively form an overall accuracy measure of effectiveness. [Ref. 9] Without this approach, the accuracy of the TES system cannot be determined.

In the discussion surrounding the TES system, direct fire variables, or biases, are the focus of this research. The ability to identify sources of variability is the key to effective system troubleshooting and repeatability of developmental tests. One must be able to develop a cause and effect relationship between the biases affecting accuracy and the probability-of-hit of the tested system in order to recreate any desired test scenario and facilitate identification of system deficiencies. Potential methods in variable identification are discussed in the error budget section of the next chapter. The thorough test designer will recognize that effort applied to this area will impact test range

requirements, instrumentation requirements, data collection plans and resource allocation. Many items involved in testing are long–lead items requiring early identification. Examples include highly–skilled test personnel, instrumented test ranges, and special ordnance, to name a few. It is important to note that resource allocation is not limited to dollars alone. Early identification of required test personnel with specific skills will facilitate efficient testing. Once involved in testing, the sudden recognition of a need for a test team member with specific skills could be catastrophic to both schedule and budget. Of equal importance to properly planning test resources is the technique that will be used to develop the plan to analyze any data collected. If statistical treatments are to be applied, defining that approach early will assist in data collection requirements, determination of sample size of test events, and procurement of prototypes. The answers provided through the development of sample sizes and test duration have major budgetary, as well as schedule, implications.

The majority of testing-related discussion, thus far, has focused upon system accuracy. The methodology being addressed in this chapter will apply to other areas of testing as well. Reliability testing, which is often classified separately, should begin immediately and under the same guidelines discussed above in terms of data collection and test design. Events occurring throughout all testing provide potential reliability data. This can be as simple as logging operating hours, laser firings and trigger pulls, or as complex as conducting failure analysis during maintenance periods. Boresighting problems involving the ITAS and the TES provided a window of reliability data-gathering potential. Maintaining testing focus upon those areas that are controllable will

provide data that is understandable and easier to interpret. Without thorough understanding of the biases impacting testing, it is impossible to establish the meaning of skewed datapoints or outliers. The detailed testing approach described here also provides the potential to explore other testing opportunities outside the terms of the current contract, whose results might provide insight into future development plans. The potential for product improvement plans or follow-on systems may be unveiled during testing of the current system and provide the beginnings of future business. The litmus test of effective testing is that each test event must provide a result that is meaningful to the program manager or the procurement decision–maker.

All of the efforts outlined to this point occur before the first test event. These preparatory events should make test execution easy in comparison to pre-test preparation. Emphasis upon pre-testing efforts is the practical approach due to the fact that, on complex instrumented ranges, an hour of instrumented test–time can translate to thousands of dollars of testing costs. Once testing commences, thoughts must turn to effective documentation of all events via the use of standardized test forms. The detailed chronology of test events is not a substitute for detailed data collection or vice versa. The two means of documenting test activity should be complementary in nature. The testing chronology will include details, such as logistics support and system design entries not included in the raw data collection log. The testing chronology will also be more useful as a historical document in support of future testing. Most importantly, it will be an invaluable tool in identifying potential outliers in the data gathered and the reasons for the unusual data points.

Scheduling of test activities must be as detailed as possible. An hourly test schedule will not only facilitate the scheduling of test personnel, but it will also dissuade interruptions from outside agencies who have been issued a copy of the test schedule. The detailed test schedule will also provide a guide for logistical support requirements and program management.

The final phase of testing is post-testing activities. The focus here must be upon timely data reduction and analysis. This will be discussed in detail in the next chapter. Potentially significant post-test activities consist of recognition of support in testing both inside and outside the test organization. Recognizing superior support of range personnel will reap benefits in future testing evolutions at that facility. The single most important post-test event is the after-action report of testing. This report will be less detailed than the final test report and will include those areas of the test that went well or require improvement from the standpoint of test execution. The after-action debriefing and report of the IPT will serve immeasurably to enhance future testing evolutions. Effective after-action activities will enhance test documentation procedures, logistics support and test scheduling. As described in this chapter, the actual effort involved in system testing is small in comparison to the efforts that take place before and after a successful test evolution.

V. A NEW APPROACH TO ASSESSING TES ACCURACY

A. IDENTIFY THE VARIABLES

In order to adequately address the accuracy issue in the TES program, an error budget is developed that details the varibles of interest that affect system accuracy. The TES mode of operation provides a period of simulated missile tracking, and then at the appropriate time, sends a burst laser transmission to the target. It is therefore appropriate to treat TES as a *delayed* direct fire system. The direct fire approach assists in the accuracy factor analysis through the simplicities associated with this assumption. The use of the Blast Laser Transmitter (BLT) laser also simplifies factor analysis in that many environmental factors such as crosswind, are significantly reduced, as well as certain weapon system influences, such as tube jump or round to round dispersion. Although the TES system is at the mercy of the tactical system in that it inherits much of the error budget through acceptance of the ITAS system boresight and autotrack signals, this fact does not provide relief from addressing other potentially significant biases such as BLT boresight to the ITAS tactical system and BLT aimpoint biases based upon engineering design specifics. Using the approach outlined in Chapter IV, the future PGTS testing efforts might address the following as significant bias categories:

<u>Cumulative Inherited Bias</u>: This would represent the bias inherited from the ITAS tactical system. It would have to be derived from the error budget associated with the ITAS system.

Gunner Aim Error: Numerous gunners were employed in the testing process. This provides the potential for variance among the engagements that could be avoided. One option would be to remove the gunner from the equation and begin with stationary system to stationary target testing to establish initial accuracy levels.

Platform Stability: This bias refers to the method used at Redstone Arsenal of firing from a mobile trailer. This bias is easily removed by moving the testing to a firmer, more solid platform such as a concrete platform.

Target belt orientation: The target belt orientation should coincide with the center of thermal mass. This should assist in reducing the system aimpoint bias associated with ITAS autotrack engagements.

BLT boresight retention: This is potentially the largest bias directly attributable to the TES system. This bias is a factor in the ability of the BLT to maintain its reference aimpoint in both the stationary and mobile configuration. No current test effort is applied to boresight retention following movement to a new firing position. This bias warrants additional consideration in future testing efforts. [Ref. 5]

BLT tube-to-tube variation: Similar to boresight retention, a potential bias among direct fire systems is variation among individual systems. The impact of this bias was observed during testing at Redstone. Accuracy biases associated with BLT manufacturing practices will only be identified through additional repeatable testing.

There are numerous other biases that would normally be addressed in any direct fire weapon system. Ambient temperature, weather, propellant temperature and crosswind are but a few. These are not interesting in the TES application due to the fact

that not all of these biases can be eliminated nor are they applicable to this system. The error budget will serve as the guide that identifies any system's pertinent biases contributing to inaccuracy. [Ref. 10]

B. STATISTICAL OPTIONS IN ACCURACY ANALYSIS

The fact that TES performs in a manner similar to direct fire systems permits application of relatively simple probability-of-hit models to establish system accuracy. Although this is a positive alternative in terms of accuracy analysis, application of the following probability of hit model does require a significant modification to the current approach to data collection. A means to capture information on chosen miss distance variables, such as boresight retention, is required. The results of a statistical treatment of accuracy data addressing the major bias categories detailed previously, will lead to a more realistic accuracy assessment and potentially necessary system design changes. The goal of the analysis should be toward designing a system that reflects the ITAS tactical system's accuracy as closely as possible.

The initial step in assessing the probability of a scoring event centers around defining the parameters associated with miss distance from the TES aimpoint. Each of the major biases described above will contribute to the cumulative mean and standard deviation of miss distance in the normal training engagement. It is generally accepted that these biases follow a bivariate normal distribution in direct fire engagements. [Ref. 11] It is also prudent to assume that these normally distributed biases are independent. Hence, in the worst case scenario, biases would be additive in their effects upon miss

distance from an aimpoint. Information regarding applicable biases from previous testing efforts is available from the U. S. Army Materiel Systems Analysis Agency (AMSAA) for a variety of systems. [Ref. 11] Such sources of information can be useful in making assumptions regarding estimators of parameters such as boresight retention variance. Once the variance values of "interesting biases" are determined, either through experimentation or assumption based upon similar system performance, a variety of simple probability-of-hit equations can be employed. One alternative model follows.

1. ***Probability-Of-Hit For Circular Target***: [Ref. 11]

The model in Equation 1 assumes that the target vehicle or impact area can be modeled as a circular target. In this scenario, the circular target assumption presents no particular concern as we are viewing the target as a thermal image centered around a "hot-spot" chosen by the ITAS. The formula used in this calculation is as follows:

$$\textbf{\textit{(Equation 1)}}\quad \textbf{\textit{P(hit)}} = 1 - e^{-(R^2/2\sigma^2)}$$

where R = target radius and σ represents the standard deviation or bias associated with the bivariate normal distribution. Using this equation requires that we possess the cumulative aimpoint error estimates for our system. This will occur only if miss distance data can be gathered from the system. An example of a simulated probability–of–hit at a given range using assumed bias values follows, where R = 1 meter and σ = .5 meter which is equivalent to a .167 mil error in aimpoint at 3000 meters. The calculation results in a P(hit) = .865.

In this simple approach to establishing probabilities of hit, we use the "mil relationship" to establish the maximum aimpoint error allowed at a given range. Aimpoint errors are normally measured in milliradians, hence the relationship that *1 milliradian = 1 meter in missed distance at 1000 meters* becomes the basis for establishing maximum aimpoint error. In the example above, the requirement to impact a target 1 meter in radius at a distance of 3000 meters equates to .333 milliradians maximum aimpoint error at the time of firing. Hence, a modest cumulative bias figure of .05 milliradians in aimpoint error translates to .15 meters in miss distance potential at 3000 meters. The example calculation above provides a more realistic scenario, yet still points out that a .95 probability of scoring event is unlikely.

The current inability to define the aimpoint of the BLT in relation to the ITAS tactical system aimpoint from the diagnostic terminal prevents the collection of meaningful data regarding the bias values required for the probability of hit calculations above. Contractor efforts to enhance engagement results were primarily restricted to archaic means such as repeated ITAS boresighting, gunner aim-off and repeated BLT system boresighting. Following this practice establishes a new accuracy baseline with each system adjustment thus sacrificing repeatability of testing or any hope of identifying dominant system biases.

2. *Multiple Regression / ANOVA Approach*: [Ref. 12]

This approach relies on the capability to measure the impact of the MILES laser on a target. It also requires the ability to measure the errors associated with the

major bias categories selected for analysis. The ability to measure boresight retention and gunner aim error (independent biases) could be regressed against the miss distance measurement at the target (dependent outcome). Through this ***AN**alysis **O**f **VA**riance* approach, correlation among the independent biases and the dependent outcome could be assessed and lead to allocation of effort in troubleshooting the system.

3. Hypothesis Testing: [Ref. 12]

Using sufficient data collected from engagements where the test conditions have remained unchanged, hypothesis testing could be conducted using the test statistic found in Equation 2.

$$\textit{(Equation 2)} \qquad z = \frac{\bar{x} - \mu_o}{\sigma/\sqrt{n}}$$

where $\bar{x}$ is derived through experimentation and the remaining parameters relating to population means μ_o, population variance, σ, and sample size n are known through the use of historical data such as that available through AMSAA. Having arrived at this stage of data analysis, one-sided hypothesis testing could be accomplished based upon a null hypothesis H_o that the mean aimpoint error is less than .333 milliradians in the case of a 3000 meter range to target. An expanded example of hypothesis testing, using .33 mils as the assumed accuracy requirement, is provided in the next section.

Similar calculations using the test statistic above in conjunction with an established α, or acceptable Type I error level, can be used to provide the appropriate sample size for experimentation by solving for n. This α error level is the degree to

which the government is willing to accept a system's mean accuracy as valid, when in fact the system's true accuracy is something less. In this thesis, all α levels are at the .05 level and all confidence intervals are at the 95th percentile. Translated, this means the government will accept a system with accuracy less than it wants five times out of 100. Or, in confidence interval terms, 95 times out of 100 the true accuracy of the system will be within the interval established through testing. The difficulty in executing hypothesis testing lies in the fact that current test design does not permit data on aimpoint error or miss distance to be gathered. Without redesigning the system so that this data can be obtained, unfounded assumptions regarding the values of these parameters must be made.

4. Binomial Distribution Assessment: [Ref. 13]

Up to this point, alternatives to assessing accuracy have focused upon the ability to make assumptions or gather data pertaining to the major biases affecting system accuracy. Yet another approach to accuracy assessment would be to view the probability of a scoring event as a binomial event. Using data similar to that found in Table 1, a value for the parameter $\hat{p}$ could be derived as an estimate for the population parameter p (probability of successful scoring event). Once in possession of this estimator of p, tables such as those found below could be used to derive a confidence interval around the desired value of p. For example, if the observed engagement success rate after firing 20 similar engagements is .85, using Table 2, we derive a 95% confidence interval that the true value of p lies between .60 and .96. Under this scenario, the developer would not be

pleased with the results nor confident that the tested system possesses a true probability of hit near .95.

5. Nonparametric Analysis:

Yet another option in assessing the quantitative accuracy of the PGTS TES system would be through a non-parametric approach. The methods applied through non–parametric statistics provide a simpler means of hypothesis testing through their disregard of population parameters or their underlying distributions. Since we believe that most of the biases are distributed normally, the use of non-parametrics in this instance is not necessary. The use of this approach indicates lack of knowledge regarding the distribution of the biases impacting upon system accuracy. The nonparametric approach is not a contributor to confident decision making when other, parametric, methods are applicable.

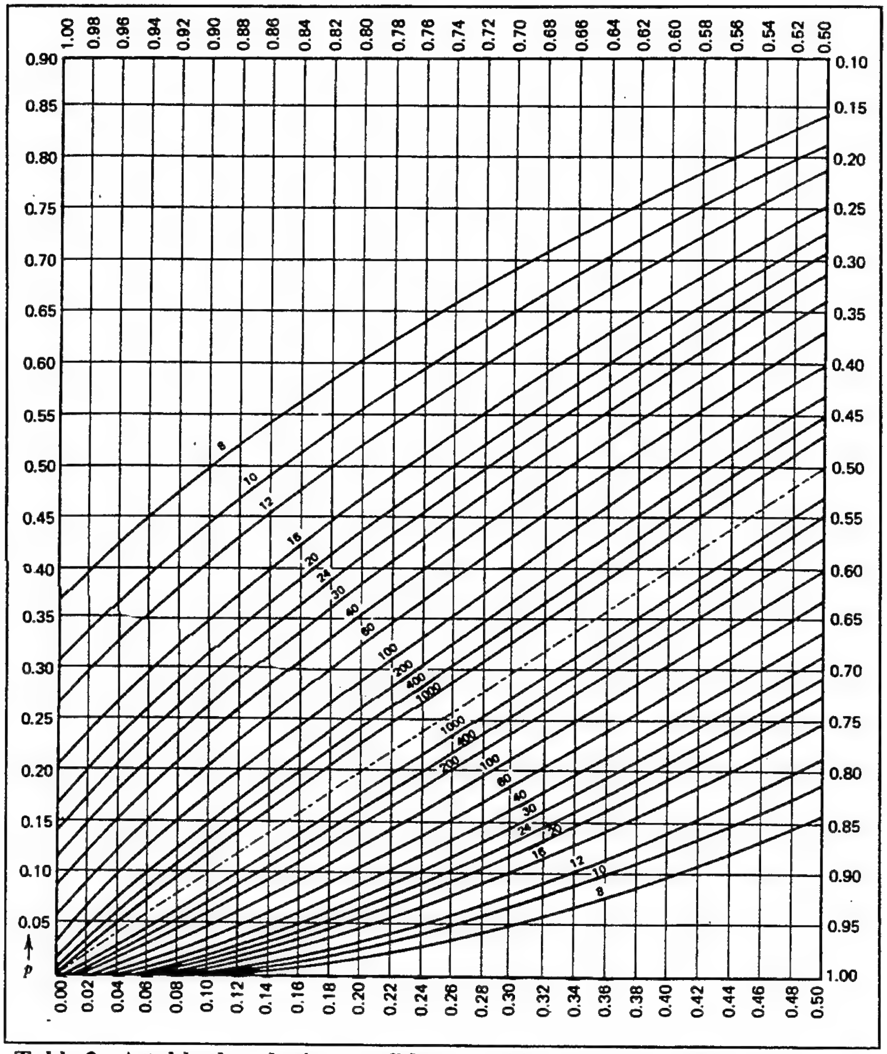

Table 2: A table that depicts confidence intervals for probability-of-hit, p, in binomial sampling. Experimental data is used to develop the estimator for p known as $\hat{p}$ (derived from the sample fraction of # hits / # shots). Based upon the sample size n, a confidence interval is read from the appropriate curves in the table. The source of this table is Reference 13.

The steps involved in taking a statistical based approach to testing are not as complex as they might appear. In the case of the TES system, execution of the following steps will lead to a more quantitative result in the final test report. A recommended

detailed testing approach is provided here with a scenario based upon this approach in the following section.

The first step in analyzing system accuracy is to choose the biases impacting system accuracy. Not all of these biases can be measured, therefore selection of those biases largest in magnitude is preferred. In the case of the TES system, let us assume that BLT boresight retention, cumulative ITAS bias that is passed from that system and cannot be resolved by the TES contractor, and gunner aim error are the potentially greatest contributors to system inaccuracies. The analysis can now focus upon these variables as the ones causing the greatest system inaccuracies. Table 3 provides an example of the data values that might be generated through this approach. The three sets of bias values in Table 3 were randomly generated via a normal distribution with mean equal to zero and standard deviation equal to .20. These parameter values were chosen through experimentation so that realistic bias values, measured in mils, could be used in Section E of this chapter.

	Cum ITAS Bias	BLT boresight retention	Gunner Aim/ Track Error	Abs value Cum error	Miss Distance @ 3000 meters= 3*CUM ERROR
Engagement					
1	0.271	-0.095	0.066	0.243	0.728
2	0.049	-0.277	-0.089	0.317	0.951
3	-0.021	-0.133	0.168	0.014	0.043
4	-0.053	0.356	0.373	0.676	2.027
5	0.154	-0.428	0.045	0.230	0.689
6	0.260	0.040	0.048	0.348	1.045
7	0.032	-0.323	0.126	0.165	0.496
8	0.090	0.110	-0.163	0.036	0.109
9	0.227	-0.156	0.015	0.087	0.260
10	-0.235	-0.070	-0.059	0.365	1.094
11	-0.044	0.009	-0.087	0.123	0.368
12	-0.090	0.008	0.173	0.091	0.273
13	0.233	0.137	-0.159	0.211	0.633
14	-0.190	-0.346	-0.179	0.714	2.142
15	0.104	-0.410	0.257	0.049	0.147
16	-0.064	0.053	-0.026	0.038	0.114
17	0.143	0.343	-0.199	0.288	0.864
18	0.217	0.255	0.132	0.604	1.812
19	0.090	0.187	-0.150	0.127	0.381
20	0.238	-0.013	-0.015	0.210	0.629
21	0.183	0.253	0.023	0.459	1.376
22	-0.101	0.127	-0.214	0.188	0.564
23	-0.144	0.189	0.194	0.238	0.715
24	-0.076	0.149	0.397	0.471	1.412
25	0.118	0.003	0.013	0.134	0.403
26	0.395	0.047	0.386	0.828	2.485
27	-0.146	-0.136	0.540	0.258	0.773
28	-0.097	0.162	-0.117	0.052	0.155
29	-0.065	-0.165	0.006	0.223	0.669
30	0.147	-0.193	0.069	0.023	0.069
MEAN				***0.260***	***0.781***
VAR	***0.026***	***0.038***	***0.038***	***0.047***	***0.423***
STDEV	***0.160***	***0.194***	***0.194***	***0.217***	***0.651***

Hypothesis Test Calculations	mean-u	-0.073
Ho: true mean < .33 mils	stdev/sqrt(n)	0.040
Ha: true mean >= .33 mils	test statistic	-1.837
	signifigance value	~.034
95% Confidence Interval Calculations	.260+/-1.96*(sigma/sqrt(n))	
Confidence Interval becomes:	.22<true mean<.34	

Table 3: Displays the data generated to support the testing scenario. All bias values were randomly generated. The results indicate a system of acceptable accuracy through hypothesis testing and development of a confidence interval.

Next, an effort should be made to conduct engagements that strive to hold one of the biases constant. This step will again require instrumentation that enables measurements to be taken of the biases described in Section A of this chapter and the miss distance at the target. The diagnostic terminal cited in the Appendix, with

cooperation from the ITAS contractor, must be modified to determine the aimpoint variations and the boresight retention rates. The ability to measure system aimpoint errors, gunner errors and miss distance will prove invaluable as shown in later examples. It may be necessary to make assumptions regarding cumulative errors being received by the ITAS if the ITAS error budget is not available. Having established acceptable methods for collecting pertinent data, experimentation is conducted at various ranges. Repeated iterations of this process, each time varying only one bias, results in a factorial design that leads to assessing which bias impacts accuracy.

The modified instrumentation used to collect data on each of the selected biases during this process will provide estimators of variation and mean for each of the biases not held constant. The resulting variability information can lead to potential system design change that may tighten the variation leading to inaccuracy. As witnessed at Redstone Arsenal, the ability to conduct numerous engagements is not a problem, therefore sample size is a minor issue.

The final step is to evaluate the gathered data, such as that in Table 2. Hypothesis testing is but one approach that can be used to determine whether the system performs as well as required. Additional approaches outlined in this chapter could also be implemented. If the means to measure miss distance at the target is available, a regression of bias values against miss distance could be conducted. This could provide insight into variables most impacting accuracy. The regression approach is not shown in the following example due to the use of the random data in Table 2 from known distributional parameters. The results would not be interesting.

C. A DATA-BASED SCENARIO

To reiterate, the values introduced in Table 3 are the result of a random number generation of thirty bias values for the three largest contributors of system inaccuracy. The size of the sample is arbitrary in this case. One method to analytically choose this sample size would be to observe that in Table 1 we achieved overall P(hit) of approximately .72. A standard rule of thumb is to ensure that this estimator of mean accuracy ($\hat{p}$), times the sample size (n), exceeds five (i.e. $np >= 5$). In this scenario we have 30 times .72, or approximately 21. This provides confidence that the sample size of 30 used in this scenario is sufficient. The data used in Table 3 is only intended to assist in describing the analysis involved in the proposed testing.

The null hypothesis that the true mean accuracy of the TES system is less than or equal to (<=) .33 mils begins the hypothesis testing upon the data. The test statistic shown in Table 3 indicates a "z-value" of -1.837. This would indicate, through simple use of normal tables, that there exists a significance value of approximately .034 in this case. This significance value means there are approximately 3.4 chances in 1,000 that the true mean accuracy of the TES is worse than .33 mils. The government would therefore accept the system if its criterion was significant at .05 or better. Remember, the .33 mils used here is only a suggested criterion for accuracy that permits a target one meter in radius to be hit at 3000 meters. There are many that do not feel hypothesis testing is appropriate in this application. One academic source reports, "Significance testing in general has been a greatly overworked procedure, and in many cases where significance

statements have been made it would have been better to provide an interval within which the true value of the parameter would be expected to lie." [Ref. 13] Using the same data in Table 2, an alternative confidence interval is easily developed using Equation 3.

$$\textbf{\textit{(Equation 3)}}\quad \bar{x} - 1.96 * \left(\frac{\sigma}{\sqrt{n}}\right) \leq x \leq \bar{x} + 1.96 * \left(\frac{\sigma}{\sqrt{n}}\right)$$

This provides a confidence interval for TES mean accuracy (x) of between .22 mils and .34 mils. The result shows that the required TES accuracy of .33 mils at 1000 meters being used in this scenario is within the range of the 95 percent confidence interval calculated. In fact, the required accuracy is at the high end of the confidence interval indicating that approximately 95 times out of 100 we can expect the true mean TES accuracy to be better than .33 mils within the above interval. This provides the same indication that the system accuracy ***using the simulated data*** is acceptable.

The overall technique described here focuses upon the major variables affecting accuracy of the TES system. If miss distance at the target can be obtained, a comparison of bias values to the response variable of miss distance could be conducted. Again, the data used was randomly generated under a set of conservative assumptions. True data will have to be scrutinized to a far greater degree to address such areas as outliers, and other factors that dirty every data set. The example does highlight the relative simplicity of applying the tools of analysis presented once the pool of potential inhibitors to accuracy has been narrowed. The example also points out the benefits of establishing accuracy via a measure such as milliradians vice simply stating that a 95% probability of a scoring event must occur. In fact, it is recommend that miss distance, vice probability

of a scoring event, become the measure through which specification compliance is measured. This approach to testing that establishes a mil relationship to accuracy would permit the majority of testing to take place at the maximum required range of 3750 meters. Although the shorter ranges outlined in the Appendix may require limited verification of accuracy, once the system has proven that it can achieve miss distance tolerances at long range, the ability to achieve similar results at shorter ranges is assured. The major effort in implementing this testing will be in the instrumentation necessary for data collection. The testing evolution observed at Redstone Arsenal would remain virtually unchanged, with the exception of increased testing involving the movement of the system between engagements to verify boresight retention. To review, a short summary of the critical steps to improving the testing process are as follow:

◆ Choose the biases, largest in magnitude that impact system accuracy. Not all of these biases can be easily measured, therefore selection of those biases largest in magnitude will provide the best return per instrumentation dollar spent.

◆ Conduct engagements that strive to hold one of the biases constant. This step allows biases impacting accuracy to be assessed individually. The ability to measure system aimpoint errors, gunner errors and miss distance will prove invaluable in establishing inter–relationships among the detractors from system accuracy.

◆ Using a detailed data collection plan, conduct testing that is repeatable and returns a sufficient database with which to perform accuracy.

◆ Attempt to derive measures of central tendency and standard deviation for each of the biases of interest.

◆ Conduct analysis upon the data as described in the testing scenario in Section E of this chapter.

◆ Finally, be prepared to explain and defend the results of the analysis. The quality of procurement decision will ride on the quality of the analysis conducted.

D. CONCLUSIONS PERTAINING TO TES ACCURACY

At present, accuracy of the TES system cannot be determined. The approach to testing currently being employed in PGTS development falls short of providing meaningful quantitative results. The lack of attention to accuracy in employing the MILES system explains an underlying cause of a historical lack of confidence by the user in the MILES system. In order to achieve realistic results in the training environment, the development of the training system must mirror the development of the tactical system. Since the MILES burst laser transmitter is wide-beamed by nature, the accuracy of the aimpoint of that laser is often discounted. This results in poor "kill rates" as the periphery of the beam is often that which is engaging the target. This advance in technology must address these shortcomings in order to be accepted as a viable training device in the fleet. The method of engaging a High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) at various ranges, a few times, under a variety of conditions does not establish the PGTS as a realistic, accurate training device suitable of emulating the TOW ITAS system.

It is the author's belief that the developer of the PGTS is approaching the system accuracy question from a disadvantageous position. Without possessing the boresight

information from the ITAS, or any capability of influencing the dispersion of the MILES laser, the contractor should concern himself with achieving the system aimpoint established by the ITAS. Once this effort is achieved, system accuracy is out of the hands of the ITAS developer. Due to the fact that the PGTS is a subsystem of the ITAS tactical system, the developer should concentrate his efforts upon proving that his BLT aimpoint is the same as the ITAS system aimpoint and that retention of this concurrent aimpoint is maintained. The majority of this effort could be conducted in the laboratory environment and would require modifications to the diagnostic system that extracts information from the ITAS system. Once the developer has established that his BLT system consistently points to the same aimpoint as the ITAS system, little else can be accomplished from an accuracy standpoint other than designing the BLT interface with the ITAS so that boresight loss is minimized.

Finally, if realism is to be preserved, testing must be expanded to include analysis of boresight retention while moving from one firing position to a subsequent firing position. Based upon observations of testing at Redstone Arsenal, this is an area of potential accuracy degradation that warrants additional research.

VI. ENHANCED INSTRUCTOR STATION (REHOST)

A. BACKGROUND

The Enhanced Instructor Station (EIS), commonly referred to as the REHOST program, is designed to replace the currently fielded TOW Gunnery Trainer (GT). The REHOST trainer is an indoor system that provides training to TOW gunners through the presentation of video based scenarios. The system used by the gunner is intended to be the functional equivalent of the tactical system. During the course of gunner engagements, the instructor has the capability to assess gunner performance via a video display that is identical to that which the gunner is observing. The instructor controls which of the 90 programmable scenarios that the gunner will be facing. Following the engagement, the gunner can be critiqued on a variety of gunner skills. Student performance appraisals include the following information:

- Hit or Miss
- Range at which missile was lost
- Ground impact location
- Miss distance in plane of target (High, Low, Left , Right)
- Gunner aiming error
- Gunner tracking score based upon sampling of aim error during the duration of the missile flight.

The primary purpose of the REHOST program is to provide improvements to the above functional aspects of the system. There will be no new capability until a future upgrade is provided that permits instructor programmable scenarios.

Major enhancements, to the currently fielded version of the REHOST trainer, provided under this contract include:

- A Pentium®–based processor
- Increased memory capacity
- A future capability to program threat scenarios via CD ROM
- User–friendly Windows®–based menus.

The effort involved in executing this portion of the PGTS program is based upon a 4 million dollar effort for five prototypes that were nearing completion at the time of the author's internship with the prime contractor. Similar to all efforts involved in the PGTS family of training devices, the design specification for the REHOST program is a 1994 update based upon the original 1983 contract.

B. OBJECTIVE

This portion of the thesis is devoted to an analysis of the REHOST testing plan. Similar to the previously discussed TES development effort, the methodology involved in executing the testing of the REHOST program is presented and critiqued. Additionally, an analysis of the improvements inherent in the REHOST system is conducted in an effort to assess the magnitude of improvement over the currently fielded system. Secondary thesis objectives focus upon the compatibility of this training device with the newly developed ITAS system and the training value of the REHOST training concept in general.

C. TESTING THE REHOST

The testing effort applied to the REHOST program was far more limited than the effort applied to the TES program discussed earlier in this thesis. It appeared that the view of the designers was that the REHOST was only an upgrade of hardware and software, and would not impact the existing performance of the trainer. Due to this assumption, a Functional Acceptance Test Plan (FATP) was developed *directly* from the 1986 version used to field the current system.

Since the REHOST is an indoor trainer, test design requirements are significantly different than those discussed in reference to the TES effort. In fact, the testing requirements of indoor systems are normally less complex than those of outdoor systems simply because many of the items referred to in Chapter IV are not applicable. This fact does not relieve the parties involved, both government and contractor, of ensuring that complete specification compliance is achieved.

The approach undertaken to assess the testing of the REHOST program was similar to the approach taken with the TES effort. First, a study of the contract under which the contractor was performing was conducted. Then the test procedures that would be used in government acceptance testing of the five prototypes were reviewed. The verification of the FATP was conducted by the author as an assigned task through the internship. This task permitted an in–depth analysis of the methodology that would be applied to the government acceptance testing effort. This document review resulted in 181 discrepancies ranging from differences in REHOST functional operation to deficiencies in establishing contract compliance.

Unlike the TES testing effort, no FATP effort was presented indicating that the REHOST system would be tested for compliance with the 1994 REHOST design specification. [Ref. 7] An example of this oversight is seen in the lack of verification of required fields of view, required audio levels, and required gunner tracking sensitivity. In its current form, the FATP developed for the REHOST system provides an operator's manual for the proper functioning of the system vice a test plan that adequately verifies specification compliance.

Upon completion of the author's review and verification of the FATP, a complete list of discrepancies relating to the system and to test methodology were submitted to the REHOST systems engineer for incorporation into the draft that would be submitted for government approval. Other than minor editorial changes and limited references to functional discrepancies, the FATP was subsequently submitted "as–is," for government review. The results of the government review were not available at the time of release of this thesis. However, it is anticipated that a thorough government review of this document will result in greater emphasis being placed upon ensuring REHOST specification compliance. It also must be noted that a thorough review of the REHOST FATP can only be accomplished with access to the system. Any government review of the REHOST test plan, without access to the system, would not be a productive effort.

Through the process of reviewing both the TES and the REHOST test procedures, it was evident that there existed distinct differences in the approach to testing between the two programs. The testing documents submitted for government approval were significantly different in their content, detail, and their approach toward achieving

specification compliance. It was anticipated that there would exist some degree of commonality among program documentation designed to achieve the same goal of prototype acceptance. It would also be a prudent assumption that the government program office tasked with development of these two PGTS programs would anticipate similar program testing documentation. As an outsider working with these programs, it would be easy to come to the conclusion that two different contractors and two different government agencies were involved in a program that possesses commonality in personnel from the program manager level and higher.

D. REHOST REALISM

The development of the REHOST system, as with all of the PGTS programs, is designed to provide realistic TOW gunnery training and instruction. While the TES effort and the upcoming PG effort meet the litmus test of realism, the REHOST program falls drastically short.

The student station, which will not be modified under this effort, does not provide functional realism with the currently fielded TOW tactical system. Knobs and switches used to perform training are different in their location and function from the current tactical system and drastically different from the ITAS system under development. This discrepancy is primarily due to the fact that the student station does not utilize an actual TOW tactical system. It uses a system that is essentially a box housing the electronics necessary for a gunner to view the preprogrammed scenarios chosen by the instructor. This is an understandable limitation given the technology of the early eighties. It is not

understandable in light of the existing video technologies being utilized to monitor the TES program.

As seen with the ET, TES and the future PG family of PGTS systems, training can be incorporated into the tactical system. All of the training conducted with these three systems will utilize the same equipment being used by TOW gunners under combat conditions. Any upgrade to the training system being developed under the REHOST program should attempt to accomplish a similar degree of realism.

An alternative approach would be to modify the REHOST program so that it is fielded concurrently with the ITAS tactical system being developed. The remainder of the PGTS programs are following this path. The REHOST program modifications could then incorporate the same philosophy as its sister programs. That philosophy is the utilization of the same hardware being used in the field as the basis of our training devices. Modifications to this program would center around the development of a new instructor station. The instructor station would only interface with the tactical system in a garrison environment or in the case of trainees, in the school environment. This approach would maintain the philosophy that the best training value is gained when a student or a user operates in the field with his actual combat equipment instead of a training substitute.

E. FUTURE RESEARCH POTENTIAL

There is question that the REHOST development effort serves as a viable training device to realistically train TOW gunners. Future research that could be conducted to

prove or disprove this statement could consist of an effort to establish a relationship between REHOST type training engagement scores and tactical system training results.

A system of developing validity coefficients that show a correlation between REHOST training and tactical training would be conducted to ensure that REHOST scores have a predictive capability of field performance. A regression analysis, similar to that proposed in Chapter V would suffice. If REHOST is then proven to provide predictive potential in assessing TOW gunner performance, then there exists potential to select the most qualified the trigger men for the TOW missile system. If REHOST results cannot be correlated to field performance, one must assess the overall viability of this training device. This area of research could be the subject of a follow–on thesis. Since TOW missiles currently cost approximately $20,000 each, substantial savings and potentially increased combat effectiveness could result from further research in this area.

VII. PROGRAM OBSERVATIONS

> ***"Providing quality products needed by the United States Armed Forces requires highly disciplined, yet flexible management framework that effectively translates operational needs into stable, affordable acquisition programs." [Ref. 8]***

Thus far, this thesis has focused upon the technical aspects of the PGTS program. In particular, emphasis has been placed upon the test methodology adopted by the TES and REHOST programs being prepared for final government acceptance of the prototype systems.

This thesis now addresses programmatic issues involving both programs that, if improved, will enhance the quality of these two systems. Unlike the technical aspects of testing design specifications, it is more difficult to apply operations research skills directly to those areas of program management that are less technical. However, areas that can be addressed by operations research skills will serve as quantitative input to the program that will contribute to any effectiveness analysis of, in this case, the PGTS systems.

One of the major areas of emphasis in the current 5000 series DoD acquisition document points out the importance of Integrated Product Teams (IPTs) at various levels. [Ref. 1] The concept of integrated management teams is not a cliché intended to bring current programs into 21st century management style. It is a concept that promotes sharing of ideas and challenges among program participants. The output from integrated product teams will be measures of program effectiveness, or metrics, that indicate program efficiency [Ref. 8]

During seven weeks of internship at the prime contractor's facility, concerns surrounding the focus of the REHOST program developed. A common focus relating to achieving contract success was no longer apparent as program schedule concerns dominated a majority of the effort. The utilization of an integrated product team that brought the government developer and the contractor together may have focused efforts in a more appropriate direction by providing immediate schedule relief. Additional benefits may have been realized in reducing risk by eliminating the development of overly ambitious revised program schedules.

As a result, recommendations centered around potential enhancements in program execution were made with the intent of providing an independent assessment from someone not involved in the daily details of the program. Some of the major areas cited for potential improvement are as follow:

Training: Advantage must be taken of the myriad of government procurement training opportunities. These range in complexity from the DSMC program manager's course to short courses. Normally, contractor participation is welcome as it tends to foster the government/industry team concept. At any rate, participation will reduce the unknowns of government expectations.

Historical Reference to Other Programs: The development of contract documents and the execution of program functions such as developmental testing are much easier when a search of the lessons–learned in other, similar, programs is conducted. This concept extends to discussions among project managers in trading ideas across current programs. This free–flowing information exchange has significant implications in the

Quality Assurance arena. It was anticipated that, through the experience of participating in the testing at Redstone Arsenal, contractor Quality Assurance representatives were charged with providing an independent assessment of program activities. In order for this function to be carried out most effectively, training of personnel in the skills of quantitative analysis seems prudent. If trained in operations research techniques, it would appear that the Quality Assurance organization in any program could serve as the honest broker of applying those techniques to program development.

Defining the Critical Path: Establishing the critical path of program events, whether manufacturing related or testing related, will assist in meeting schedule deadlines and reducing program risk. Current REHOST scheduling documents do not highlight critical path program events that should be weighted more heavily in the event that those items impact other program events. An example is software loading into the upgraded processor that must be accomplished prior to commencing contractor validation of test procedures. Definition of the critical path provides the primary tool for prioritization of program resource allocation.

Risk Assessment: Risk must be prioritized, and based upon this prioritization, appropriate program resources applied. In the circumstances surrounding the REHOST program, the risk associated with continuing program execution versus temporarily halting the allocation of resources that may be applied to other programs is worthy of research. Risks associated with continuing a program with significant schedule and design challenges will likely lead to procurement of a system of lesser quality than originally intended. Until the true training value of the REHOST program or the accuracy

of the TES system is established, both of these programs are in a high risk state.

Clearly Defined Data Requirements: At some point a program must address the minimum data requirements to validate system performance. The method of testing based solely upon hit or miss results is too limited in scope. Enhancements to current data collection efforts would include such items as system operating hours, laser firings, range conditions and the data items previously discussed in Chapters III through V.

VIII. RECOMMENDATIONS

At present, it is not possible to determine the accuracy of the TES system or the training value of the REHOST program through quantitative analysis. This fact should result in a significant amount of concern by the program manager and the procurement decision maker. A thorough review of the method being utilized to establish accuracy of the TES program and future research into the training value of the REHOST system will remedy this situation.

The current specification compliance methodology being applied to the acceptance of both REHOST and TES systems does not support a valid verification that these systems will perform in the manner which is expected under current contracts. Any procurement decision made based upon the results of testing to date would have to infer that the TES system is not capable of achieving a .95 probability of achieving a scoring event at any range. The more thorough statistical approach presented in Chapters III through V would provide quantitative information capable of establishing current system accuracy. The procedures for thorough testing are in place in the TES program, but a significant enhancement to data collection must take place.

The REHOST program must begin with abandoning the concept that the modifications being made to the former system are essentially cosmetic and therefore do not require thorough validation of contract specifications. A test plan that thoroughly validates all contract specifications is warranted when the subject system is being procured at the prototype cost of $800,000 per copy. It is also reasonable to assume that

the contractor views these modifications as substantial due to the fact that in excess of 100 hours of contractor effort has been applied to the primary testing document for the REHOST system. This level of effort indicates a desire to thoroughly test REHOST, however, the FATP being submitted for government review in December, 1995, did not achieve that goal. The primary question is, if this program does not substantially modify the existing gunnery system, then does it provide value in training our forces?

The training value resident in the TES system is undeniable. It permits a TOW gunner to conduct training in the field at any time when in the presence of his system. The ability to conduct this type of training in a flexible fashion, at the lowest unit levels, will prove invaluable. Most importantly, it conducts the training with the very same equipment that will be used in the event of conflict.

As indicated in Chapter IV, the validation of training value in the REHOST program requires further research. An expanded study that establishes the correlation between REHOST training performance and TOW gunnery skills in the field should be a prerequisite to procurement.

In closing, the reader is reminded that this thesis is not intended to intimate that an acceptable level of commitment is not resident in the PGTS program, rather, it is intended to provide an operations research perspective to program management that may lead to more effective analysis of program development through the ability to quantify, where possible, factors impacting system performance. The contractor's commitment to excellence is self–evident through his enthusiastic support of the internship that served as the basis for this work.

APPENDIX

SELECTED TES TRAINER TEST PROCEDURES

This appendix is provided so that the reader may follow in detail, the testing procedures implemented during TES program development and to contrast them with the test methodology presented in this thesis. It is also provided as ready reference to the issues discussed in Chapters III through V of the thesis. This section of the Test Procedures provides a complete chronology of the events that each of the prototype systems would be subjected to at Redstone Arsenal during government prototype acceptance testing.

Attention is drawn to the limited testing procedures relating to the accuracy of the TES system and the lack of testing procedures verifying boresight retention following movement of the HMMWV mounted TES system. The annotations shown in the Appendix represent the final editing effort prior to government acceptance testing.

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.a Installation	3.2.1 1.3 Shall #1,2 & 3 3.2.2.3 Shall #1 3.2.6 (PGTS) Shall #3 & 4	Step #1 Open Transit Cases #1 and #2. Unpack TES mode subassemblies and cables.	Verify all components available		
		Step #2 Start stop watch and record time. Perform installation of the TES mode subassemblies and cables onto the HMMWV using a two person crew without using any special tools. Perform boresight alignment of the Trainer Missile Tube to ITAS.	Verify installation and alignment		
		Step #3 Stop watch and record time.	Time < 30 minutes		
		Step #4 Start stop watch and record time. Remove TES mode subassemblies and cables from the HMMWV.	Verify removal		
		Step #5 Pack TES mode subassemblies and cables into Transit Cases #1 and #2. Stop watch and record time.	Time < 30 minutes Verify all components repacked		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.a Installation (Continued)		**Step #6** Repeat Steps #1 to #6 with installation onto the Tripod Mount.	Time < 30 minutes for installation and alignment Time < 30 minutes for removal		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.b Boresight	3.1.4.1 Shall #1 3.2.1 Shall #6 & 7 3.2.1.1.3 Shall #1 3.2.1.1.4 Shall #1	Step #1 Remove Boresight Assembly from Stow Bag and install onto TOW launch tube and insure that assembly is aligned to launch tube and the ITAS direct view optics aperture.	Verify installation		
		Step #2 Boresight Tactical System and perform special start-up procedure in Section 5.3.5 to compensate for ITAS optical misalignment and crosshair position (if still required; upon completion go to Step #5). Select **TRAINING** on the **Main Menu**. Select **TES** then BS (Boresight) on the **Training Menu**. Look through the ITAS sight and verify that it is in both the direct view optics and the NFOV modes. Change from thermal sight and/or WFOV modes if required. Verify that the circular alignment reticle is visible. If not, select **UP/DOWN** or **RT/LT** as necessary on the **Training Boresight Menu** and adjust until reticle is visible in the direct view optics.	Verify reticle present		
		Step #3 Continue adjusting the boresight reticle position using the **UP/DOWN** or **RT/LT** controls until it approaches the center of the direct view optics reticle.	Verify adjustment of reticle		
		Step #4 Select SLOW on the **Training Boresight Menu** and continue UP/DOWN or **RT/LT** adjustment until boresight reticle overlaps each of the lines of the direct view optics reticle.	Verify speed change and reticle centering		
		Step #5 Exit to the **Main Menu**. Enter **TRAINING**, **TES** and **TOW2a**. With the boresight collar still in place, enable the function on the Diagnostic Terminal which turns on the boresight reticle. Observe that the reticle is still aligned with the crosshair as in Step #4.	Verify boresight position and retention		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.b Boresight (Continued)		Step #6 Using the Diagnostic Terminal, turn off the boresight reticle. Remove the boresight collar. Fire a missile in the TES mode. After the post flight smoke images have cleared, reinstall the boresight collar and use the Diagnostic Terminal to turn the boresight reticle on. Observe that the boresight alignment has been retained.	Verify turn off of boresight reticle, verify missile firing and boresight position and retention		
		Step #7 Using the ITAS menu, exit training and allow 5 seconds for the power to be removed from the embedded training. Again using the ITAS menu, enter **TRAINING, TES**, and **TOW 2a**. On the Diagnostic Terminal, turn on the boresight reticle. Verify via the intersection/positioning of the ITAS direct view optics reticle (crosshair) and the TES boresight reticle that boresight alignment is retained.	Verify power down Verify intersection of ITAS and boresight reticles		
		Step #8 On the Diagnostic Terminal, turn off the boresight reticle. Exit to Main Menu. Remove Boresight Assembly and replace into Stow Bag.	Verify removal and storage		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.c TES Mode - Supports ET Function	3.2.1.4.6 Shall #4 (PGTS Spec) 3.2.1 Shall #3 3.2.1.1.9.1 Shall #4 & 5	Step #1 Install TES mode subassemblies and cables. Boresight per 5.3.b Steps #1 to #6. Position a test target at approximately 2240 meters down range.	Verify installation and target positioning		
		Step #2 Select **TRAINING** on the **Main Menu**. Select ~~TES ET~~ on the **Training Menu**. Select ~~either a~~ TOW2A ~~or TOW2B~~ on the TES MENU. Using the autotracker mode select the test target. (If the Autotrack function is not fully implemented in ITAS, use the Diagnostic Terminal selection "H" to set the Autotrack enable bit.) Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. The range should read approximately 2240 meters. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Have the stopwatch available. Simultaneously press the Trigger and start the stopwatch. Note both the time delay from trigger pull to missile launch and the tine duration of the obscuration period. When the missile explodes on target, stop the stopwatch. According to the missile flight time to a given range presented in the Hughes Report, this time from launch to end of flight will be between 9 - 10 seconds.	Verify range display ±50 meters Verify launch and simulated missile flight Time of flight ≈ 10 sec		
		Step #3 After missile explosion is observed in the display, reset the Missile Arm Lever on the Traversing Unit. (Currently needs a TES TMT installed for ITAS to recognize a reset.) Using the manual mode, select the down range target. Immediately press the trigger and observe the start of a new missile flight sequence. While the missile is flying out, move the traversing unit. Verify that the movement of the crosshairs (GAE) causes the missile to move and thus is an input to the TOW Flight Equations.	Verify launch, simulated missile flight and missile movement		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.c TES Mode - Supports ET Function (Continued)		Step #4 After missile explosion is observed in the display, reset the **Missile Arm Lever** on the Traversing Unit. (Currently needs a TES TMT installed for ITAS to recognize a reset.) Using the manual mode, select the down range target. Press the trigger and observe the start of a new missile flight sequence. While the missile is flying out, reset the **Missile Arm Lever** on the Traversing Unit and observe the missile flight response to a wire break condition. Step #5 Repeat Steps #2, #3 and #4 for selection of a TOW2B.	Verify launch, simulated missile flight Observe missile continues flight along last commanded path Verify results as above		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.d MILES Message Structure	3.2.1.4.6 Shall #10 (PGTS Spec) 3.1 Shall #6 3.1.2.9 Shall #2 3.2.1.1.9.1 Shall #16 & 17 3.2.1.3.3 Shall #1,2,2a,2b,2c,2d & 2e	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6. Step #2 Using the Diagnostic Terminal, load PID #0001 (11110000000) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (110110110000) and a Man Kill Code 27 (11001000111). Step #3 With the Diagnostic Terminal, set a target default range ~~≥~~ ≈2240 meters insure a missile flight time of at least 10 seconds. Step #4 Locate the optical detector, which has been connected to either a storage oscilloscope or a logic analyzer, in front of the laser transmitter aperture and send a command (via the FCS or a trigger pull) to fire the missile. With a stop watch, measure that a nominal time of ~~1 to~~ approximately 1.5 sec has elapsed from trigger pull to start of laser transmissions. Step #5 Monitor the pulse position and timing sequence to verify 32 TOW messages of eight words each (first 16 messages at 2 per second for 8 seconds and the last 16 messages at 8 per second for 2 seconds) followed by 128 Man Kill words (offset from the start of the last missile message by ~~<133.3~~ >121.3 millisec) have been transmitted.	Verify set-up Verify PID Verify ≥2240 meters Verify set-up Verify elapsed time ~~1 to~~ 1.5 ±0.5 sec 8 words per TOW msg; Msg rate of 2/sec for 8 sec; Msg rate of 8/sec for 2 sec; 128 MK words starting ~~<133.3~~ ≥ 121.3 msec after start of last TOW msg		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.d MILES Message Structure (Continued)		Step #6 Examine the pulse position of the TOW word and the Man Kill word to verify the data structure matches Figure 5.3-~~1~~-3a.	Verify data per Fig 5 3-~~1~~-3a		
		Step #7 Command a missile firing as in Step #3 but with the laser transmitter aimed at a MILES II detector and console. Note the response for a **KILL BY 07** on the MILES II console display along with the **PID ####** (Player Identification - 0001 in this case).	KILL 07; PID 0001		
		Step #8 Repeat Steps ~~#2 to~~ #6 and using the following Player ID numbers: 0160 (00010110010) 0330 (00000001111) 1160 (000101110010) (Bin 6-8 shift) 2160 (000101110010) (Bin 6-8 shift) 3160 (000101110010) (Bin 6-8 shift)	Kill 07; Data per PID 0160; 5.3-1b PID 0330; 5.3-1c PID 1160; 5.3-1d PID 2160; 5.3-1e PID 3160; 5.3-1f		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.e MILES Message Compression vs. Range	Supporting Data to: 3.2.1.2.3.1 Shall #1	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6 if necessary.	Verify set-up		
		Step #2 Using the Diagnostic Terminal and load Player ID #0160 (00010110010) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (110110110000) and a Man Kill Code 27 (11001000111).	Verify PID		
		Step #3 Using the Diagnostic Terminal, load a default range of 200 meters into the ET Cards.	Verify 200 meters		
		Step #4 Locate the optical detector, which has been connected to either a storage oscilloscope or a logic analyzer, in front of the laser transmitter aperture and send a command (via the FCS or a trigger pull) to fire the missile.	Verify set-up		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.e MILES Message Compression vs. Range (Continued)		Step #5 Monitor the message timing sequence to verify ~~32~~ ≥22 TOW messages of eight words each followed by 128 Man Kill words have been transmitted. With a stop watch or storage oscilloscope, measure that the total transmission time of the message sequence is approximately 2.52 seconds.	Verify at least 22 TOW msgs in t = 1.1 ±0.2 sec; Verify ~~32~~ ≥25 TOW msgs and 128 MK ~~msgs~~ words in t = 2.52 ±0.2 sec		
		Step #6 Repeat Steps #2 to #5 using the following default ranges and measure the total transmission times. RANGE / FLIGHT TIME(t_f) / TRANSMISSION TIME(t_t) 593 meters / 2.55 sec / 3.45 sec 1187 meters / 4.89 sec / 5.79 sec 2051 meters / 9.05 sec / 9.95 sec 3066 meters / 15.29 sec / 10.9 sec 3703 meters / 20.23 sec / 10.9 sec	Verify 32 TOW msgs and 128 MK ~~msgs~~ words transmitted in time t_f = 2.55 ±0.2 t_t = 3.45 ±0.2 t_f = 4.89 ±0.2 t_t = 5.79 ±0.2 t_f = 9.05 ±0.2 t_t = 9.95 ±0.2 t_f = 15.29 ±0.2 t_t = 10.9 ±0.2 t_f = 20.23 ±0.2 t_t = 10.9 ±0.2		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.f Simulation Cycle Time	3.2.1.4.6 Shall #1 & 2 (PGTS Spec) 3.2.1.1.9.1 Shall #10 & 11	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6 If necessary.	Verify set-up		
		Step #2 Attach the Diagnostic Terminal and load Player ID #0160 (00010110010) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (110110110000) and a Man Kill Code 27 (11001000111).	Verify PID		
		Step #3 Using the Diagnostic Terminal load into the ET Cards a default range of 3750 meters.	Verify range		
		Step #4 Locate the optical detector which has been connected to an oscilloscope in front of the laser transmitter aperture and send a command (via the FCS or a trigger pull) to fire the missile.	Verify set-up		
		Step #5 With a stop watch, measure first the time from trigger pull to the presentation of the explosion in the display (end of missile flight) and then the additional to the end of the MILES coded laser transmissions as shown on the oscilloscope. NOTE: Total = Launch Delay (1.5 ±0.5 sec) + Time of Flight + Delay to start of Man Kill (0.1 sec) + Man Kill (0.8 sec)	Time to "end of laser transmission" ~~≤ 1.2 time~~ to "end of missile flight" ~~or~~ ≤ 1 sec ~~NOTE: Total = Launch Delay (1.5 sec) + Time of Flight + Delay to start of Man Kill (0.1 sec) + Man Kill (0.8 sec)~~		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.g MILES II Code Transmission	3.1.2.9 Shall #1 3.2.1.1.9.1 Shall # 14 & 15	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6.	Verify set-up		
	3.2.1.2.1 Shall #2 3.2.1.3.4 Shall #1	Step #2 Attach the Diagnostic Terminal load Player ID #0160 (00010110010) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (11011011000) and a Man Kill Code 27 (11001000111).	Verify PID		
		Step #3 Equip a target vehicle with a MILES II Console, Detector Belts, Battery Box and Combat Vehicle Kill Indicator as shown in Figure 5.3-2.a. Power-up the MILES II System and using an **UMPIRE KEY** reset the system and define the vehicle type to the MILES II Console as a M60A1. With the TOW Test Simulator, verify MILES II operation and reset system.	Verify set-up		
		Step #4 Position the target vehicle at a range > 1500 meters but < 2000 meters from the FTT/ITAS system.	Verify > 1500, < 2000 meters		
		Step #5 Select **TRAINING** on the **Main Menu**. Select **TES** on the **Training Menu**. Select either a **TOW2A** or **TOW2B** on the **TES Menu**. Using the autotracker mode select the MILES II equipped target vehicle. The vehicle may be stationary or moving along a random coarse for this test. Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Press the trigger and keep the crosshairs in the track box. When the missile explodes on target, observe the resultant response from the MILES II System. Read the display on the target's MILES II Console for a **KILL BY 07** along with the PID #### (Player Identification - 0160 in this case).	Verify menu selections Range > 1500 meters Kill 07; PID 0160		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.g MILES II Code Transmission (Continued)		Step #6 Repeat Steps #2, #4 and #5 using the following Player ID numbers: 330 (00000001111) 1160 (00010110010) (Bin 6-8 shift) 2160 (00010110010) (Bin 6-8 shift) 3160 (00010110010) (Bin 6-8 shift)	Kill 07; PID 0330 PID 1160 PID 2160 PID 3160		
		Step #7 Repeat Steps #2 and #4 If required.	Verify PID; Verify set-up; Verify range		
		Step #8 Select **TRAINING** on the Main Menu. Select **TES** on the Training Menu. Select either a **TOW2A** or **TOW2B** on the **TES** Menu. Using the autotracker mode select the MILES II equipped target vehicle. The vehicle should be stationary for this test. Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Press the trigger and keep the crosshairs in the track box for 3 to 4 seconds after the obscuration has cleared. Slowly move the crosshairs out of the track box until the ITAS reverts to the crosshair mode. Keep the crosshairs off of the target for the duration of the missile flight. When the missile explodes, observe the resultant response from the MILES II System. Read the display on the target's MILES II Console for a **MISS BY 07** along with the PID #### (Player Identification - 0160 in this case).	Verify menu selections Range > 1500, < 2000 meters Miss 07; PID 0160		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.h MILES II Range Performance	3.2.1.4.6 Shall #5 (PGTS Spec) 3.2.1.2.3.1 Shall #1	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6.	Verify set-up		
		Step #2 Attach Diagnostic Terminal and load Player ID #0160 (00010110010) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (11011011000) and a Man Kill Code 27 (11001000111).	Verify PID		
		Step #3 Equip a target vehicle with a MILES II Console, Detector Belts, Battery Box and Combat Vehicle Kill Indicator as shown in Figure 5.3-2.a. Power-up the MILES II System and using an **UMPIRE KEY** reset the system and define the vehicle type to the MILES II Console as a M60A1. With the TOW Test Simulator, verify MILES II operation and reset system.	Verify set-up		
		Step #4 Position the target vehicle at a range of approximately 2000 meters from the FTT/ITAS system.	Verify approximately 2000 meters		
		Step #5 Select **TRAINING** on the Main Menu. Select **TES** on the Training Menu. Select either a **TOW2A** or **TOW2B** on the **TES** Menu. Using the autotracker mode select the MILES II equipped target vehicle. The vehicle should be stationary for this test. Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Press the trigger and keep the crosshairs in the track box. When the missile explodes on target, observe the resultant response from the MILES II System. Read the display on the target's MILES II Console for a **KILL BY 07** along with the PID #### (Player Identification - 0160 in this case).	Verify menu selections Range = approximately 2000 meters Kill 07; PID 0160		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.h MILES II Range Performance (Continued)		Step #6 Repeat Steps #4 and #5 using the following representative vehicle ranges as required to bound minimum and maximum system range performance as may be impacted by laser performance and atmospheric "seeing" conditions: 200 meters <500 meters 500 meters <1000 meters 1000 meters <1500 meters 1500 meters <2500 meters 2500 meters <3000 meters 3000 meters <3500 meters 3500 meters <3750 meters 3750 meters <4000 meters ≥4000 meters	Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160 Kill 07; PID 0160		
5.3.i MILES II Resolution Performance	3.2.1.4.6 Shall #5 (PGTS Spec) 3.2.1.2.1 Shall #3 3.2.1.3.2 Shall #1	Step #1 Set-up TES mode hardware with ET Cards (may be located in FCS or in laboratory test fixture). Boresight per 5.3.b Steps #1 to #6. Step #2 Attach Diagnostic Terminal and load Player ID #0160 (000101100l0) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (110110110000) and a Man Kill Code 27 (11001000111). Step #3 Equip a target vehicle and a stationary target board with MILES II Consoles, Detector Belts, Battery Boxes and Combat Vehicle Kill Indicators as shown in **Figure 5.3-2.a**. Power-up the MILES II Systems and using an **UMPIRE KEY** reset the systems and define the vehicle type to the MILES II Consoles as a M60A1. With the TOW Test Simulator, verify MILES II operation and reset the systems.	Verify set-up Verify PID Verify set-up		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.i MILES II Resolution Performance (Continued)		Step #4 Position the target vehicle and stationary target board as shown in **Figure 5.3-1** at a range of approximately 2000 meters from the FTT/ITAS system. Horizontally separate the target vehicle and target board (end-to-end) by 5 meters.	Verify approximate 2000 meter range and 5 meter separation		
		Step #5 Select **TRAINING** on the **Main Menu**. Select **TES** on the **Training Menu**. Select either a **TOW2A** or **TOW2B** on the **TES Menu**. Using the autotracker mode select the MILES II equipped target vehicle. The vehicle should be stationary for this test. Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Press the trigger and keep the crosshairs in the track box. When the missile explodes on target, observe the resultant response from both targets' MILES II Systems. Read the display on the target vehicle's MILES II Console for a **KILL BY 07** along with the **PID ####** (Player Identification - 0160 in this case). Read the display on the stationary target board's MILES II Console for no indication of either a **KILL BY 07** or a **MISS BY 07** along with the **PID ####** (Player Identification - none in this case) number.	Verify menu selections Range = approximately 2000 meters Kill 07; PID 0160 on target vehicle No indication on stationary target board		
		Step #6 If the display on the stationary target board's MILES II Console indicates either a **KILL BY 07** or a **MISS BY 07**, repeat Step #5 and increase the separation between the target vehicle and the stationary target board in 1 meter increments until the display on the target vehicle's MILES II Console has no indication of either a **KILL BY 07** or a **MISS BY 07**. Record the separation distance.	Kill 07; PID 0160 on target vehicle No indication on stationary target board		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.i MILES II Resolution Performance (Continued)		Step #7 Repeat Steps #4, #5 and #6 (if required) using the following representative vehicle ranges as required to verify system resolution (separation) performance over range: 200 meters $<$500 meters 500 meters $<$1000 meters 1000 meters $<$1500 meters 1500 meters $<$2500 meters 2500 meters $<$3000 meters 3000 meters $<$3500 meters 3500 meters $<$3750 meters 3750 meters $<$4000 meters $>$4000 meters	For each range verify: Kill 07; PID 0160 on target vehicle No indication on stationary target board; if indication is observed, separate the target board from the target vehicle until no indication is observed and record distance		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.j MILES II Console - Physical/Basic Communications Interface	3.1.2.7 Shall #1,2,3,4 & 5 3.2.1.1.9.2 Shall #2	Step #1 Set-up as shown in **Figure 5.3-2.b** a MILES II System consisting of: MILES II Console - VDD (P/N 12936278-LES) 4 ea Detector Belts (P/N 12939365) CVKI (P/N 11749720) Battery Box (P/N 11749790) Cables (P/N 12945702 and 12945712)	Verify set-up		
		Step #2 Attach a convenient +24 VDC power input (battery or power supply).	Verify power		
		Step #3 Attach Cable 4A1W2 (P/N 1404CA1002 [138111]) to the Trainer Missile Tube, the FCS and J5 of the MILES II Console.	Verify set-up		
		Step #4 Attach the Diagnostic Terminal to permit monitoring of the MILES II Console message transfer between the console and the ET Cards in the FCS.	Verify set-up		
		Step #5 Power-up the MILES II System and set the vehicle configuration for vehicle type HMMWV with a PID #### (specified in console selected). ~~Turn-off the MILES II System.~~	Verify configuration		
		Step #6 ~~Power-up first the TES Mode and then Power-up the MILES II System.~~ Enter TRAINING and then select option "D" to activate the MILES II monitor. Select TES mode. Via the Diagnostic Terminal, transmit a UNIT CONFIGURATION REQUEST (Menu 1, option Q). Verify the receipt by the ET Cards of ~~the MILES II initialization~~ UNIT CONFIGURATION REQUEST and the transmission of the UNIT CONFIGURATION REPORT messages.	Verify transmission of BB 28 06 00 00 E9 and receipt of message BB 28 08 E1 ## ## XXXX		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.k MILES II Console - GaAs Transceiver Interface	3.1.2.10 Shall #1,2,3,4 & 5 3.1.2.7 Shall #2 3.2.1.1.6 Shall #1 3.2.1.1.9.2 Shall #2	Step #1 Set-up as shown in **Figures 5.3-2.a and .b** two (2) MILES II Systems consisting of: MILES II Console - VDD (P/N 12936278-LES) 4 ea Detector Belts (P/N 12939365) CVKI (P/N 11749720) Battery Box (P/N 11749790) Cables (P/N 12945702 and 12945712)	Verify set-up		
		Step #2 Attach a convenient +24 VDC power input (battery or power supply).	Verify power		
		Step #3 For one system, attach Cable 4A1W2 (P/N 1404CA1002 [138111]) to the Trainer Missile Tube, the FCS and J5 of the MILES II Console.	Verify set-up		
		Step #4 To this system, attach the Diagnostic Terminal to permit monitoring of the MILES II Console message transfer between the console and the ET Cards in the FCS.	Verify set-up		
		Step #5 Power-up the MILES II System ~~and set the vehicle configuration for vehicle type HMMWV~~ with a PID #### (specified in console selected). ~~Turn-off the MILES II System.~~	Verify configuration		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.k MILES II Console - GaAs Transceiver Interface (Continued)		Step #6 ~~Power-up first the TES Mode and then Power-up the MILES II System. Boresight ITAS/TES per 5.3.b Steps #1 to #6.~~ Enter TRAINING and then select option "D" to activate the MILES II monitor. Select TES mode. Via the Diagnostic Terminal, verify the transmission and receipt by the ET Cards of ~~the MILES II initialization and UNIT CONFIGURATION~~ AMMO LEVEL SET and SET VEHICLE TYPE messages.	Verify transmission and receipt of messages ~~BB 38 08 51 ## ##~~ BB 4A 1E 0E ... 00 07 (in Bytes 13-14) ... ; BB 40 06 4A 01 4B; BB 02 06 0E 00 D1; BB 40 00 02 01 03 on Diagnostic Terminal		
		Step #7 Power-up the second MILES II System which has been located in front of the Training Missile Tube.	Verify set-up		
		Step #8 Conduct a TES Mode TOW firing. Verify that the second MILES II console has registered a KILL BY 07 with the proper PID #### (specified in console selected).	Kill 07; PID ~~0160~~ #### on second system MILES II Console		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.1 MILES II Console - Message Interfaces for Ammo Levels (Continued)		Step #7 Allow the TES Mode to set the missile **AMMO LEVEL SET** to an initial default of seven (7) missiles and note the change on the MILES II Console display. Verify via the Diagnostic Terminal that an **ACKNOWLEDGE** message has been sent by the MILES II Console and received in the ET processor.	Verify BB 4A 1E 0E ...00 07 (in Bytes 13-14) ... and BB 40 06 4A ~~nn nn~~ 01 4B on Diagnostic Terminal		
		Step #8 Via the Diagnostic Terminal (Menu 1, Option "P"), send an **AMMO LEVEL REQUEST** to the MILES II Console and verify its transmission.	Verify BB 49 05 01 09 on Diagnostic Terminal		
		Step #9 Via the Diagnostic Terminal, verify an **AMMO LEVEL** response has been sent from the MILES II Console to the ET processor.	Verify BB 49 1D ... nn nn (in Bytes 12-13) ... on Diagnostic Terminal		
		Step #10 Fire a TES Mode missile simulation and note the decrement of one (1) missile change on the MILES II Console display. (Verify via the Diagnostic Terminal that the ET processor sent a **AMMO LEVEL SET** message to the MILES II Console and that an **ACKNOWLEDGE** message was received by the ET processor.) Repeat missile firings to verify the decrement of missile count until no more missiles are displayed. Attempt to fire once more and verify that no simulated missile launch occurs.	Verify BB 4A 1E 0E ...nn nn (in Bytes 13-14) ... and BB 40 06 4A nn nn on Diagnostic Terminal		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.1 MILES II Console - Message Interfaces for Ammo Levels	3.1.2.7 Shall #2 3.2.1.1.9.2 Shall #2	Step #1 Set-up as shown in **Figure 5.3-2.b** a MILES II System consisting of: MILES II Console - VDD (P/N 12936278-LES) 4 ea Detector Belts (P/N 12939365) CVKI (P/N 11749720) Battery Box (P/N 11749790) Cables (P/N 12945702 and 12945712)	Verify set-up		
		Step #2 Attach a convenient +24 VDC power input (battery or power supply).	Verify power		
		Step #3 Attach Cable 4A1W2 (P/N 1404CA1002 [138111]) to the Trainer Missile Tube, the FCS and J5 of the MILES II Console.	Verify set-up		
		Step #4 Attach the Diagnostic Terminal to permit monitoring of the MILES II Console message transfer between the console and the ET Cards in the FCS.	Verify set-up		
		Step #5 Power-up the MILES II System ~~and set the vehicle configuration for vehicle type HMMWV~~ with a PID #### (specified in console selected). ~~Turn-off the MILES II System.~~	Verify configuration		
		Step #6 ~~Power-up first the TES Mode and then Power-up the MILES II System.~~ Enter TRAINING and then select option "D" to activate the MILES II monitor. Select TES mode. ~~Boresight ITAS/TES per 5.3.b Steps #1 to #6. Via the Diagnostic Terminal, verify the receipt by the ET Cards of the MILES II initialization and UNIT CONFIGURATION messages.~~	Verify ~~receipt of message BB 28 08 E1 ## ## on Diagnostic Terminal~~ set-up		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.n MILES II Console - Message Interfaces for Events Reports	3.1.2.7 Shall #2 3.2.1.1.9.2 Shall #2 3.2.1.2.2 Shall #1	Step #1 Set-up as shown in **Figure 5.3-2.b** a MILES II System consisting of: MILES II Console - VDD (P/N 12936278-LES) 4 ea Detector Belts (P/N 12939365) CVKI (P/N 11749720) Battery Box (P/N 11749790) Cables (P/N 12945702 and 12945712)	Verify set-up		
		Step #2 Attach a convenient +24 VDC power input (battery or power supply).	Verify power		
		Step #3 Attach Cable 4A1W2 (P/N 1404CA1002 [138111]) to the Trainer Missile Tube, the FCS and J5 of the MILES II Console.	Verify set-up		
		Step #4 Attach the Diagnostic Terminal to permit monitoring of the MILES II Console message transfer between the console and the ET Cards in the FCS.	Verify set-up		
		Step #5 Power-up the MILES II System ~~and set the vehicle configuration for vehicle type HMMWV~~ with a PID #### (specified in console selected). ~~Turn off the MILES II System.~~	Verify configuration		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.n MILES II Console - Message Interfaces for Events Reports (Continued)		Step #6 ~~Power-up first the TES Mode and then Power-up the MILES II System.~~ Enter TRAINING and then select option "D" to activate the MILES II monitor. Select TES mode. ~~Boresight ITAS/TES per 5.3.b Steps #1 to #6. Via the Diagnostic Terminal, verify the receipt by the ET Cards of the MILES II initialization and UNIT CONFIGURATION message.~~	Verify ~~receipt of message BB 28 08 E1 ## ## on~~ set-up of Diagnostic Terminal		
		Step #7 Via ~~the Diagnostic Terminal or~~ an Optical/Laser based MILES II code transmitter generate a KILL in the MILES II Console.	Verify Kill xx; PID nnnn is displayed on MILES II Console		
		Step #8 Via the Diagnostic Terminal, verify an EVENT REPORT has been sent from the MILES II Console to the ET processor.	Verify BB 33 15 xxxx nnnn .... (xxxx = event #) (nnnn = event code/subcode) on Diagnostic Terminal		
		Step #9 Insert the CONTROLLER KEY into the MILES II Console and RESET the unit.	Verify reset on MILES II Console		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.n MILES II Console - Message Interfaces for Events Reports (Continued)		**Step #10** Via the Diagnostic Terminal, verify a **RESET** has been sent from the MILES II Console to the ET processor and that the missile count has been reset via a missile **AMMO LEVEL SET** to an initial default of seven (7) missiles. Note the change on the MILES II Console display.	Verify BB 33 15 xxxx ~~02~~ 06 00 ... (xxxx - event #) on Diagnostic Terminal Verify BB 4A 1E 0E ...00 07 (in Bytes 13-14) ... and BB 40 06 4A nn nn on Diagnostic Terminal		
		Step #11 Allow the TES Mode to Fire several missile simulations and note the decrease in missile count on the MILES II Console display.	Verify decrease in missile count on MILES II Console		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.n MILES II Console - Message Interfaces for Events Reports (Continued)		Step #12 Via ~~the Diagnostic Terminal or~~ an Optical/Laser based MILES II code transmitter generate a **KILL** in the MILES II Console.	Verify Kill xx; PID nnnn is displayed on MILES II Console		
		Step #13 With an **UMPIRE GUN**, perform an external **OPTICAL RESURRECTION** on the MILES II system. Via the Diagnostic Terminal, verify a **EVENTS REPORT** has been sent from the MILES II Console to the ET processor and that the missile count has returned to the count level last displayed at the completion of Step #13.	Verify BB 33 15 xxxx 04 ... on Diagnostic Terminal; Verify missile count on MILES II Console display is same as count displayed at completion of Step #11		
		Step #14 Fire one missile simulation and note the decrease in missile count by one on the MILES II Console display.	Verify MILES II Console displayed missile count has decreased by one		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.o MILES II Console - Kill Inhibit	3.2.1.1.9.2 Shall #1 & 3	Step #1 Set-up as shown in **Figure 5.3-2.b** a MILES II System consisting of: MILES II Console - VDD (P/N 12936278-LES) 4 ea Detector Belts (P/N 12939365) CVKI (P/N 11749720) Battery Box (P/N 11749790) Cables (P/N 12945702 and 12945712)	Verify set-up		
		Step #2 Attach a convenient +24 VDC power input (battery or power supply).	Verify power		
		Step #3 Attach Cable 4A1W2 (P/N 1404CA1002 [138111]) to the Trainer Missile Tube, the FCS and J5 of the MILES II Console.	Verify set-up		
		Step #4 Attach the Diagnostic Terminal to permit monitoring of the MILES II Console message transfer between the console and the ET Cards in the FCS.	Verify set-up		
		Step #5 Power-up the MILES II System ~~and set the vehicle configuration for vehicle type HMMWV~~ with a PID #### (specified in console selected). ~~Turn off the MILES II System.~~	Verify configuration		
		Step #6 ~~Power-up first the TES Mode and then Power-up the MILES II System. Enter~~ TRAINING and then select option "D" to activate the MILES II monitor. Select TES mode. ~~Boresight ITAS/TES per 5.3.b Steps #1 to #6. Via the Diagnostic Terminal, verify the receipt by the ET Cards of the MILES II initialization and UNIT CONFIGURATION messages.~~	Verify ~~receipt of message BB 28 08 E1 ## ## on~~ set-up of ~~Diagnostic Terminal~~		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.o MILES II Console - Kill Inhibit (Continued)		Step #7 Via ~~the Diagnostic Terminal or~~ an Optical/Laser based MILES II code transmitter generate a **KILL** in the MILES II Console.	Verify Kill xx; PID nnnn is displayed on MILES II Console		
		Step #8 Via the Diagnostic Terminal, verify an **EVENT REPORT** has been sent from the MILES II Console to the ET processor.	Verify BB 33 15 xxxx nnnn .... (xxxx = event #) (nnnn = event code/subcode) on Diagnostic Terminal		
		Step #9 Attempt to fire a simulated missile round while the MILES II Console indicated a KILL status.	Verify NO simulated missile launch occurs		
		Step #10 Insert the **CONTROLLER KEY** into the MILES II Console and **RESET** the unit.	Verify reset on MILES II Console display		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.o MILES II Console - Kill Inhibit (Continued)		Step #11 Via the Diagnostic Terminal, verify a **RESET** has been sent from the MILES II Console to the ET processor and that the missile count has been reset via a missile **AMMO LEVEL SET** to an initial default of seven (7) missiles. Note the change on the MILES II Console display.	Verify BB 33 15 xxxx 03 06 00 ... (xxxx - event #) on Diagnostic Terminal Verify BB 4A 1E 0E ...00 07 (in Bytes 13-14) ... and BB 40 06 4A nn nn on Diagnostic Terminal		
		Step #12 Fire several missile simulations and note the decrease in missile count on the MILES II Console display.	Verify missile simulation occurs in response to a trigger pull		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.p Weapons Effects Signature Simulator	3.2.1.4.4 Shall #1,2 & 3 (PGTS Spec)	Step #1 Set-up the TES Mode equipment with the ITAS hardware and the ET Cards located in the FCS.	Verify set-up		
	3.1.2.4 Shall #1 & 2 3.2.1.1.9.1 Shall #12 & 12b	Step #2 Select TRAINING on the Main Menu. Select TES on the Training Menu. Select either a TOW2A or TOW2B on the TES Menu.	Verify menu selections		
		Step #3 Install an M-80 blast simulator into the rear of the BLT and attach the wires to the E1 and E2 terminals.	Verify M-80 installation		
		Step #4 Observe the SAFETY PRECAUTIONS to insure the rear hemisphere safety zone behind the TOW launch tube is clear of personnel and equipment. Press the trigger and observe that the M-80 blast simulation detonates. Through the ITAS thermal display observe that the blast coincides with the simulated launch of the TOW missile. Using a stop watch, measure the time between trigger depression and the detonation of the M-80 blast simulator.	Verify Safety Precautions followed Verify WESS effect coincides with simulated missile launch Time 1.5 sec ±~~0.2~~ 0.5 sec		
		Step #5 Repeat Steps #2 and #3 as required to insure satisfactory WESS effects are achieved.	Record data and verify as required		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.p Weapons Effects Signature Simulator (Continued)		Step #6 Repeat Step #3. Step #7 Observe the SAFETY PRECAUTIONS to insure the rear hemisphere safety zone behind the TOW launch tube is clear of personnel and equipment. Step #8 Select **TRAINING** on the **Main Menu**. Select **BIT** on the **Training Menu** and then select **BLT**. Step #9 Observe that Test #8 (M-80) produces the message '**REMOVE M-80 DEVICE**' in the sight.	Verify M-80 installation Verify Safety Precautions followed Verify menu selections Verify message Remove M-80 Device displayed		
5.3.q Voltage Input Sources	3.2.1.1.10 Shall #1 3.3 (PGTS) Shall # 1p,1q,1r & 1s	Step #1 Set-up the TES Mode equipment with the ITAS hardware and the ET Cards located in the FCS. Step #2 Attach Cable Assembly 4A1W1 to the J1 connector on the BLT and obtain TES Mode power from the Converter/Charger (P/N 13364816). Step #3 Attach Diagnostic Terminal and load Player ID #0160 (00010110010) into the ET Cards. It should be noted that the ET Cards have been programmed for both a TOW missile Code 07 (110110110000) and a Man Kill Code 27 (11001000111).	Verify set-up Verify set-up Verify PID		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.q Voltage Input Sources (Continued)		Step #4 Equip a target vehicle with a MILES II Console, Detector Belts, Battery Box and Combat Vehicle Kill Indicator as shown in **Figure 5.3-2.a**. Power-up the MILES II System and using an **UMPIRE KEY** reset the system and define the vehicle type to the MILES II Console as a M60A1. With the TOW Test Simulator, verify MILES II operation and reset system. Boresight ITAS/TES per 5.3.b Steps #1 to #6.	Verify set-up		
		Step #5 Position the target vehicle at a range > 1500 meters from the FTT/ITAS system.	Verify > 1500 meters		
		Step #6 Select **TRAINING** on the Main Menu. Select **TES** on the Training Menu. Select either a **TOW2A** or **TOW2B** on the **TES** Menu. Using the autotracker mode select the MILES II equipped target vehicle. The vehicle may be stationary or moving along a random coarse for this test. Using the right handgrip, fire the laser range finder. Observe the range display on the ITAS Thermal Display. Before pressing the Trigger make sure the autotracker gate is not flashing but is solid. Press the trigger and keep the crosshairs in the track box. When the missile explodes on target, observe the resultant response from the MILES II System. Read the display on the MILES II Console for a **KILL BY 07** along with the **PID ####** (Player Identification - 0160 in this case).	Verify menu selections Range > 1500 meters Kill 07; PID 0160		
		Step #7 Remove Cable Assembly 4A1W1 from the Charger/Converter and obtain TES Mode power from the Battery Tube (P/N 13364815).	Verify removal and power		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.q Voltage Input Sources (Continued)		Step #8 Repeat Step #6.	Verify menu selections Range > 1500 meters Kill 07; PID 0160		
		Step #9 Remove Cable Assembly 4A1W1 from the Battery Tube and the J1 connector on the BLT.	Verify removal		
		Step #10 Attach Cable Assembly 4A1W7 to the J1 connector on the BLT and obtain TES Mode power from the HMMWV 28VDC connector.	Verify power		
		Step #11 Repeat Step #6.	Verify menu selections Range > 1500 meters Kill 07; PID 0160		

TABLE 5-3 TES MODE INSPECTIONS

Test Title	Specification Reference	Procedure	Expected Results	Inspection Results	Inspection Authority
5.3.r HMMWV Performance	3.1.4.3.2 Shall #1	Step #1 Install the TES mode hardware, the ITAS and A MILES II system onto a TOW capable HMMWV.	Verify installation		
		Step #2 Perform Test 5.2.a IBIT Step #1 defined in Table 5-2.	Verify message "TRAINING, BIT PASS"		
		Step #3 Perform Test 5.3.b Boresight Steps #1 to #8 defined in this table (Table 5-3).	Verify Boresight		
		Step #4 Perform Test 5.3.b Range Performance Steps #3 to #5 defined in this table (Table 5-3). Perform Step #6 for the maximum range previously observed for the TMT serial number being evaluated. If maximum range performance is not achieved, move target vehicle closer until KILL BY 07, PID #### (PID of MILES II Console being used) is achieved.	Verify KILL BY 07, PID #### at 2000 meters; verify KILL BY 07, PID #### at max range		
		Step #5 Perform Test 5.3.p Weapons Effects Signature Simulator Steps #2 to #4 defined in this table (Table 5-3). Place a MILES II equipped target vehicle at a nominal range of 2000 meters. Observe KILL BY 07, PID ####. Repeat Test 5.3.p Steps #3 and #4 as required (minimum of 3 firings) to demonstrate successful performance repeatibility. Relocate target vehicle to maximum range obtained in Step #4 above. Reboresight as defned in Test 5.3.b Steps #1 to #8. Repeat Test 5.3.p Steps #3 and #4(minimum of 3 firings) to demonstrate successful repeatibility of KILL BY 07, PID ####.	Verify WESS (M-80) firing; verify KILL BY 07, PID #### at 2000 meters; verify KILL BY 07, PID #### at max range		

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